

Continuous Water-Cooling Monopolar Radiofrequency for Non-Invasive Skin Tightening: Technical Innovations of the Volnewmer System

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ABSTRACT

Since 2002, 6.78 MHz monopolar radiofrequency (MRF) has been a gold standard for non-invasive skin tightening. The Volnewmer system improves upon conventional MRF devices with two key innovations: a hidden-edge curved-electrode to mitigate hot spots and a continuous active water-cooling mechanism for uninterrupted epidermal protection. This case report evaluates Volnewmer's clinical efficacy on a 62-year-old female experiencing facial ptosis, malar volume loss, and deep nasolabial folds. The patient received a single treatment of 600 pulses using a 4.0 cm² tip at energy levels 4.5–5.5. The device's continuous cooling safely directed thermal energy into the deep dermis, stimulating collagen contraction and neocollagenesis. At 12 weeks post-treatment, the patient demonstrated notable improvements in mid-face positioning, jowling reduction, and skin elasticity, experiencing only transient erythema. These preliminary findings suggest this innovatively engineered MRF system is a safe, effective option for treating facial laxity, though larger controlled studies remain necessary.

Keywords: Collagen; Skin aging; Rejuvenation; Radio waves; Elasticity

INTRODUCTION

Skin aging is a multifactorial biological process characterized by progressive alterations in the extracellular matrix. Dermal thinning, loss of elasticity, and wrinkle formation are driven primarily by a reduction in soluble collagen content, diminished fibroblast biosynthetic activity, and upregulation of matrix metalloproteinases. To counteract these changes without the morbidity and downtime associated with surgical facelift, aesthetic medicine has increasingly relied on energy-based devices. Among these, monopolar radiofrequency (MRF) has emerged as a gold standard for non-invasive skin tightening and facial rejuvenation.

Clinical MRF began in 2002 when the ThermoCool TC (Solta Medical) received U.S. Food and Drug Administration (FDA) clearance for periorbital wrinkle treatment [1]. Subsequent multicenter studies validated its utility for full facial and neck laxity [2,3]. The fundamental principle of MRF relies on the targeted delivery of alternating current through tissue at 6.78 MHz, generating volumetric heating in the deep dermis and subcutaneous interface according to the relationship $E = (I/A)^2 \times Z \times t$, where E is the accumulated tissue energy, I is the current, A is the cross-sectional tip area, Z is the tissue impedance, and t is the exposure duration.

This mathematical relationship indicates that increasing the cross-sectional tip area (A) reduces superficial current

density, thereby shifting the heating profile deeper into the tissue to target the subcutaneous fibroseptal network. Early single-pass, high-energy protocols were effective but associated with significant patient discomfort and occasional adverse events including fat atrophy [4,5]. Clinical practice subsequently evolved toward multiple-pass, low-energy techniques to maximize neocollagenesis while minimizing epidermal damage [6-9].

Over the past decade, South Korea has become an increasingly active contributor to MRF device development. High patient demand for non-invasive facial rejuvenation has driven Korean manufacturers to develop next-generation platforms that seek to address limitations of existing devices, including procedure-related pain, consumable costs, and variability in energy delivery uniformity [10].

One such platform, the Volnewmer (Classys Inc.), received FDA 510(k) clearance in 2024 (K240248) and introduces two fundamental engineering innovations: a proprietary hidden-edge curved-electrode tip design and a continuous active water-cooling mechanism that replaces pulsed consumable cryogen gas [11]. The purpose of this report is to review the technical rationale and clinical evidence underpinning these innovations in the context of the broader evolution of MRF technology, and to present a clinical case report demonstrating their application.

CASE REPORT

1. Patient Demographics

The patient is a 62-year-old female of East Asian descent, presenting with a Fitzpatrick Skin Type II. Her chief complaints were centered on the visible effects of gravity and chronological aging, specifically “heavy” nasolabial folds, a loss of cheek volume (malar flattening), and significant blurring of the jawline due to submental and mandibular laxity.

In her relevant aesthetic and medical history, the patient reported no previous surgical rhytidectomy, thread lifting, or injectable fillers within the last 3 months. She is a non-smoker with no history of chronic systemic diseases, such as uncontrolled diabetes or autoimmune connective tissue disorders, which could potentially diminish the body’s fibrotic response to thermal stimulation.

2. Treatment Protocol

The treatment was executed using the Volnewmer monopolar RF system, utilizing a 6.78 MHz frequency. This specific frequency is calibrated to penetrate the resistance of the epidermis to reach the collagen-dense layers of the dermis and the fibroseptal network of the subcutaneous fat.

A total of 600 shots were delivered using a 4.0 cm² gold-plated tip. The energy level was maintained at a clinical range of 4.5 to 5.5, titrated based on the impedance of specific facial zones. To ensure patient safety and comfort, the device’s integrated four-step cooling system was set to its maximum capacity, providing a cryogen-like effect that protects the epidermis while allowing the deep tissue to reach the therapeutic window of 55°C to 65°C. The hand-piece’s vibration feature was also utilized to modulate the patient’s perception of heat during high-energy delivery.

To ensure consistency in clinical evaluation, standardized two-dimensional digital photographs were obtained at baseline and at all follow-up visits. The patient was positioned against a non-reflective, monochrome background. During photography, the patient was instructed to maintain a relaxed, neutral facial expression with the Frankfort horizontal plane parallel to the floor. To further minimize variables, hair was secured away from the face using a uniform headband, and all makeup, sunscreen, and topical skincare products were completely removed from the skin surface prior to imaging.

3. Clinical Outcomes

The post-treatment photographs, reviewed at the 12-week mark, demonstrated improvement in facial soft-tissue positioning compared with baseline. There was an apparent lifting of the mid-face region and a reduction in the depth of the nasolabial folds and marionette lines.

Some improvement in mandibular contour definition was also observed, with apparent reduction in jowling compared with baseline images. Overall skin texture appeared improved on inspection. The patient reported no significant procedure-related downtime, with transient erythema resolving within two hours post-procedure.

Written informed consent was obtained from the patient for the medical procedures described and for the publication of this case-illustrated review, including the use of any identifiable clinical photographs and accompanying medical details (Fig. 1-3).



Fig. 1. Clinical photographic comparison of a 62-year-old female patient at baseline and 12 weeks following a single treatment session with 6.78 MHz monopolar radiofrequency. (A) Baseline: pre-treatment imaging demonstrates characteristic signs of advanced chronological aging and gravitational ptosis. Notable findings include significant mid-facial volume loss, descent of the malar fat pads resulting in prominent nasolabial folds, and a loss of mandibular definition with visible jowling. (B) 12 Weeks post-treatment: follow-up imaging reveals a visible lifting effect through the mid-facial soft tissues. There is a marked softening of the nasolabial folds and marionette lines, accompanied by a sharper, more defined jawline.



Fig. 2. Right oblique view: baseline vs. post-treatment. (A) Clinical photographs at baseline and (B) 3 months post-treatment. Visual improvements are noted in the nasolabial folds and jawline contour.

4. Review: Evolution of 6.78 MHz Monopolar Radiofrequency Technology

1) Mechanism of action

The therapeutic efficacy of 6.78 MHz MRF relies on dielectric heating of tissue. The rapid oscillation of polar molecules generates frictional heat, raising dermal and septal temperatures to 55°C-65°C while the epidermis is protected by active cooling [4].

The application of heat yields a dual tissue response: the immediate disruption of heat-labile hydrogen bonds causes mechanical shrinkage of collagen fibrils, while a delayed healing cascade (upregulating heat shock proteins and TGF- β 1) stimulates fibroblasts. It should be noted that the neocollagenesis and collagen contraction described here are inferred from established MRF literature; histological confirmation was not directly evaluated in this clinical case [12].



Fig. 3. Left oblique view: baseline vs. post-treatment. (A) Clinical photographs at baseline and (B) 3 months post-treatment.

2) Generational evolution of monopolar radiofrequency platforms

The MRF landscape was established by the ThermoCool TC (2002), which utilized a 1.0 cm² tip with a single-pulse, high-energy protocol. The third-generation Thermage CPT (2009) introduced a 3.0 cm² tip and five-pulse energy delivery interleaved with cryogen cooling, exploiting the gate control theory of pain to reduce procedural discomfort. The current fourth-generation Thermage FLX (2018) features a 4.0 cm² tip, multidirectional vibration, and AccuREP™ technology—a real-time impedance matching system that algorithmically adjusts energy delivery per pulse to account for tissue variability across anatomical zones [13].

Despite these advances, certain clinical limitations persist. Pulsed cryogen-gas cooling creates intermittent gaps in epidermal thermal protection between RF pulses. The concentration of electrical current density at the edges of planar electrodes—the edge effect—generates hot spots at tip margins that restrict the maximum energy that can be safely delivered and contribute to procedural pain. Furthermore, the consumable nature of cryogen cartridges represents a recurring operational cost. These unmet needs motivated the development of next-generation platforms.

5. Technical Innovations of the Volnewmer System

1) Overview

This RF monopolar device is a 6.78 MHz monopolar capacitive RF device operating at a maximum power output of 115 W. FDA 510(k) clearance was granted in 2024

(K240248). The system supports dual handpieces, enabling simultaneous connection of two different tip sizes that can be alternated during treatment without interruption. The device incorporates four interchangeable tip sizes: the I-tip (0.25 cm², periorbital), F-tip (3.0 cm², upper face), V-tip (4.0 cm², lower face), and S-tip (16.0 cm², body), each integrating the system's core electrode and cooling innovations.

2) Hidden-edge curved-electrode design: mitigating the edge effect

The edge effect is a well-recognized physical phenomenon in planar-electrode RF devices: electrical current density concentrates at the periphery of the electrode, creating hot spots at the tip margins. This localized overheating causes disproportionate pain, increases the risk of superficial burns, and limits the maximum energy that can be safely applied to tissue. Conventional MRF devices have addressed this limitation only partially through cooling or impedance matching.

The Volnewmer employs a proprietary hidden-edge electrode configuration in which the electrode edges are recessed into the interior of the tip body and the outer margins of the tip are slightly elevated from the skin surface. This geometry is intended to prevent the electrode periphery from coming into direct contact with the skin, thereby reducing edge-effect current concentration at the margin-skin interface. Energy distribution across the active treatment area is consequently expected to be more uniform, reducing the primary source of edge-related hot spots.

Complementing the hidden-edge design, the tip head

is formed with a curved surface and incorporates a tilting mechanism that allows the head to conform dynamically to the curvilinear contours of the face and jawline. This ensures flush, gapless contact across anatomically complex surfaces, maintaining consistent energy delivery and preventing areas of inadequate coupling that could cause uneven treatment or focal arcing. Together, the hidden-edge electrode and curved tilting head may enable the safer delivery of higher cumulative energy levels, potentially expanding the therapeutic window for collagen remodeling.

Yang et al. [14] conducted a randomized split-face study in 31 participants to evaluate the differential clinical effects of the device's tip sizes. The study found that the smaller F-tip (3.0 cm^2) yielded superior outcomes for upper facial wrinkles, including periorbital rhytides and glabellar lines, while the larger V-tip (4.0 cm^2) was more effective for treating lower facial laxity—specifically nasolabial fold depth and marionette lines.

These findings reflect the well-established relationship between electrode area and penetration depth: the larger tip achieves a deeper, more columnar thermal profile suited to treating the subcutaneous fibrous septae responsible for lower facial laxity, while the smaller tip concentrates energy more superficially and precisely for fine wrinkle treatment. This study provides direct clinical evidence that this device's range of tip geometries enables anatomically tailored treatment protocols.

3) Continuous active water-cooling system

Conventional MRF devices—including the Thermage FLX and Oligio X (Wontech)—utilize pulsed cryogen gas to cool the epidermis. In pulsed systems, cooling occurs as discrete bursts synchronized with RF pulse delivery, creating temporal gaps in epidermal thermal protection between pulses. During these intervals, superficial heat can accumulate, particularly during high-fluence or multiple-pass treatments, imposing practical limits on energy delivery and treatment density.

The water-cooling monopolar device replaces consumable cryogen gas with a continuous active water-cooling mechanism. Water at a controlled temperature circulates within the tip continuously—before, during, and after each RF pulse—maintaining the epidermal surface at 12°C – 14°C throughout the entire treatment session. This uninterrupted thermal extraction at the skin surface serves two simultaneous functions. First, it provides continuous and reliable epi-

dermal protection against thermal injury regardless of RF emission timing, eliminating the temporal vulnerabilities inherent in pulsed cooling architectures.

Second, by continuously removing heat at the surface, it establishes a sustained thermal gradient that acts as a barrier to premature heat dissipation from the deeper dermis—a principle analogous to thermal insulation in reverse. This gradient allows RF energy to accumulate more efficiently in the target dermal layer, enabling the tissue to reach and sustain the therapeutic temperature window of 55°C – 65°C required for collagen fibril contraction and neocollagenesis stimulation.

Kim [11] evaluated the efficacy of continuous water-cooling 115 W MRF in a cohort of 50 patients. Using quantitative surface profilometry, the study demonstrated a statistically significant improvement in skin roughness (value)—a validated surrogate marker for fine wrinkle severity—of 28.42% immediately following treatment. At the one-month follow-up, this improvement was sustained at 26.23%, indicating durable dermal remodeling consistent with ongoing neocollagenesis. No serious adverse events were reported, supporting the safety profile of continuous water-cooling delivery at this power level.

4) Real-time impedance tracking

This RF device incorporates real-time skin impedance measurement at every RF pulse. As tissue impedance varies with local hydration, epidermal thickness, and anatomical location [6], a fixed energy output can result in undertreatment in high-impedance areas or thermal injury in low-impedance zones. The system's impedance tracking algorithm automatically adjusts energy output per pulse to compensate for these variations, ensuring that the intended thermal dose is consistently delivered irrespective of inter-patient or intra-facial variability. This function is conceptually equivalent to the AccuREP™ technology in the Thermage FLX and represents a fundamental safety requirement for modern high-energy MRF delivery.

DISCUSSION

The water continuous cooling system RF monopolar device represents a technologically distinct approach to 6.78 MHz MRF that addresses two persistent limitations of conventional platforms: the edge effect and the intermittent nature of pulsed cryogen cooling. These two innovations are mechanistically complementary. Eliminating the edge

effect through the hidden-edge electrode design removes the primary source of tip-margin hot spots that constrain energy delivery.

The continuous water-cooling system then provides the uninterrupted epidermal protection necessary to take advantage of this increased safety margin—enabling practitioners to deliver higher cumulative energy levels without sacrificing patient safety or comfort.

The intended consequence of the hidden-edge design is a more uniform energy distribution across the entire active tip surface. In conventional planar-electrode devices, practitioners must limit energy delivery to levels that keep the tip-margin hot spots below the threshold for epidermal injury, even though the central electrode area may be receiving substantially less energy than could be therapeutically beneficial.

The hidden-edge design removes this constraint, allowing the full tip area to operate at higher and more consistent energy densities. This has direct implications for clinical efficacy: greater uniformity of dermal heating translates to more complete activation of the wound-healing cascade and more homogeneous neocollagenesis across the treatment field.

The continuous water-cooling architecture introduces a mechanistic advantage not present in pulsed-gas systems. By maintaining a constant 12°C–14°C at the epidermal surface throughout RF emission, the system creates a persistent and steep reverse thermal gradient between the cooled epidermis and the target dermis. In pulsed-gas systems, the epidermis transiently warms during the inter-pulse interval, partially neutralizing this gradient before the next cooling burst. Continuous cooling prevents this temperature recovery, effectively sustaining the thermal barrier throughout the treatment session.

The practical result is more efficient dermal heat accumulation per pulse and lower epidermal peak temperatures at equivalent RF energy settings—a fundamentally favorable shift in the therapeutic ratio. The clinical study by Kim [11] demonstrating 28.42% immediate and 26.23% sustained improvement in skin roughness provides quantitative evidence that this theoretical advantage translates to measurable treatment outcomes.

The dual-tip size finding of Yang et al. [14] has important implications for treatment planning. The observation that the 3.0 cm² F-tip outperforms the 4.0 cm² V-tip for upper facial wrinkles—while the reverse is true for lower

facial laxity—reflects the depth-penetration physics of spot-size variation: smaller electrodes concentrate energy more superficially and are optimal for fine periorbital rhytides, while larger electrodes achieve a deeper thermal column suited to treating the subcutaneous fibrous septae that govern lower facial contouring. The device's range of four anatomically differentiated tip sizes (0.25, 3.0, 4.0, and 16.0 cm²) enables systematic application of this principle across the full face and body, a versatility not consistently available on competing single-or-dual-tip platforms.

This case illustrates the potential clinical application of the device's engineering features. The hidden-edge tip is designed to produce a more uniform energy field, which may be particularly relevant when treating older patients with reduced dermal thickness. The observed clinical response—including apparent improvement in tissue positioning and skin texture—is consistent with the wound-healing cascade described in the established MRF literature, though histological confirmation was not performed in this case and individual outcomes cannot be generalized.

1. Comparison with Cryogen-Gas Systems

When compared with the Thermage FLX and Oligio X—both of which employ pulsed cryogen-gas cooling—the Volnewmer presents potential advantages and trade-offs. The continuous water-cooling approach eliminates consumable gas costs and removes the temporal gaps in epidermal protection inherent in pulsed architectures, while the hidden-edge electrode is designed to reduce the edge-effect constraint. While the device's 115 W maximum power output is numerically lower than the 400 W capacity of some competitors, we hypothesize that the continuous cooling dynamics may partly compensate by improving deep tissue heat retention. However, these comparisons must be interpreted cautiously in the absence of head-to-head clinical data.

2. Suitability for Asian Skin

For patients with Asian Fitzpatrick skin types III–V, preservation of the epidermal-dermal junction is paramount to prevent post-inflammatory hyperpigmentation (PIH). Because MRF relies on electrical impedance-based heating rather than chromophore absorption, it is inherently color-blind and carries a near-zero risk of PIH compared with

ablative laser modalities. The device's continuous water-cooling provides additional security in this regard by maintaining consistent and low surface temperatures even in the context of high cumulative energy delivery. The clinical populations studied by Yang et al. [14] and Kim [11] were predominantly Asian, and no PIH events were reported in either study, a finding consistent with the expected safety profile of this platform for Asian skin types, though the limited sample sizes preclude definitive conclusions.

3. Limitations

The clinical evidence base for this RF device currently consists of two published studies with relatively small sample sizes (N=31 and N=50) and follow-up periods limited to one month. The absence of blinded, randomized head-to-head comparative trials against the Thermage FLX or other next-generation platforms limits formal comparative efficacy claims. Clinical assessment in this report relies on the subjective interpretation of paired photographs by the treating physician. Objective, validated scales (e.g., Fitzpatrick Wrinkle Scale), standardized photographic protocols (controlling for lighting, head position, and expression), and quantitative physical measurements were not utilized, which may influence reader perception.

This case report constitutes preliminary hypothesis-generating evidence, and larger prospective studies with quantitative outcome measures, blinded independent evaluation, and follow-up extending to six to twelve months are required to establish the long-term efficacy and safety profile of this device.

4. Conclusion

The Volnewmer incorporates two engineering modifications to the established 6.78 MHz monopolar capacitive radiofrequency platform. Its hidden-edge curved-electrode design is intended to reduce the edge effect—a recognized limitation of conventional planar-electrode RF tips—with the aim of producing more uniform energy distribution and enabling safer delivery of higher cumulative doses. Its continuous active water-cooling system provides uninterrupted epidermal protection and is designed to optimize deep dermal heat accumulation through a sustained reverse thermal gradient, while removing the consumable cost of pulsed cryogen-gas architectures.

The available clinical evidence, though limited in sample size and follow-up duration, suggests clinically meaningful improvements in skin texture and laxity consistent with neocollagenesis. The case reported herein illustrates the clinical application of these features in a real-world treatment context. Future independent, multi-center randomized controlled trials with validated quantitative outcome measures will be essential to fully characterize the comparative efficacy and safety of this platform relative to established devices.

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CONFLICTS OF INTEREST

The primary author serves as a Key Opinion Leader (KOL) and clinical speaker for Volnewmer device. However, the manufacturer had no role in the clinical treatment of the patient, the subjective outcome assessment, manuscript drafting, or the decision to submit this work for publication. Also, Chang-Hwan Cho is an editor of the Journal of Aesthetic Surgery and Laser Science; however, was not involved in the peer reviewer selection, evaluation, and decision process of this article. Otherwise, the authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: CHC. Data curation: IR. Formal analysis: CHC. Investigation: all authors. Methodology: all authors. Project administration: IR. Writing—original draft: CHC. Writing—review & editing: all authors.

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