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Microneedle fractional radiofrequency for reducing upper eyelid skin laxity: characteristics and comparison with other techniques



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HIGHLIGHTS

Microneedle fractional radiofrequency improves mild–moderate upper eyelid laxity with minimal downtime. It is safe and non-invasive alternative, but surgery remains the gold standard for advanced cases.

ABSTRACT

The aim of the study was to present microneedle fractional radiofrequency as a method for reducing upper eyelid skin laxity and to compare it with other treatment techniques, both non-invasive and surgical. The article discusses the mechanism of action, technical parameters, clinical effects, and safety profile of microneedle radiofrequency. A comparative analysis with surgical blepharoplasty, fractional CO_2 laser, HIFU, plasma, mesotherapy, and fillers was performed. The results showed that microneedle fractional radiofrequency is an effective and safe alternative for patients with mild to moderate upper eyelid skin laxity, offering visible improvement without a long recovery period. Although, surgical blepharoplasty remains the most effective method in advanced cases, non-invasive techniques are becoming increasingly important due to technological advances and growing patient expectations regarding comfort and procedural safety.

Key words: microneedle fractional radiofrequency, upper eyelids, skin laxity, blepharoplasty, CO_2 laser, HIFU, mesotherapy

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INTRODUCTION

Skin aging is a complex, multi-stage process involving both intracellular alterations and structural changes in the extracellular matrix. It is particularly evident in delicate, exposed regions of the face, such as the periocular area. The upper eyelid skin, among the thinnest in the human body, measures approximately 0.3–0.5 mm in thickness and has minimal adipose and supportive collagen structures, making it highly susceptible to aging factors, including ultraviolet (UV) radiation and oxidative stress.

Endogenous factors, such as reduced collagen and elastin production and hormonal changes, together with exogenous factors, including UV exposure, environmental pollutants, and repetitive facial movements, contribute to decreased skin elasticity and firmness. This results in tissue laxity, fold formation, sagging, and overall aesthetic deterioration [1]. Upper eyelid laxity may impair peripheral vision, cause a sensation of ocular heaviness and lead to fatigue, with severe cases restricting the visual field [2]. Consequently, patients and specialists in aesthetic medicine, ophthalmology, and plastic surgery are actively seeking effective interventions to restore periocular skin firmness.

This study was conducted as a narrative review and comparative analysis of microneedle fractional radiofrequency in the treatment of upper eyelid skin laxity. Relevant articles published in English were selected based on their focus on the mechanism of action, clinical efficacy, safety, and technical parameters of microneedle radiofrequency, as well as comparative studies involving other treatment modalities.

MECHANISM OF ACTION

Radiofrequency (RF) microneedling is a minimally invasive technique that combines microneedling with radiofrequency energy to stimulate skin regeneration. The procedure involves creating controlled microinjuries in the dermis using needles that penetrate up to 4.5 mm, delivering RF energy to induce neocollagenesis, neoelastogenesis, and angiogenesis [3]. This process generates thermal damage zones, activating fibroblasts and increasing the production of type I and III collagen, as well as elastin [4]. RF microneedling also induces growth factors such as TGF-β (transforming growth factor β), which support wound healing and angiogenesis [5]. The treatment causes protein coagulation within the dermis, resulting in tissue contraction and lifting effects [6]. Histological studies have demonstrated that RF microneedling leads to collagen homogenization and reorganization, with increased density and a more orderly arrangement detectable after one week, and further improvements observed after one month.

TYPES OF DEVICES AND TREATMENT PARAMETERS

RF technology has become a widely used method in non-invasive and minimally invasive aesthetic procedures. RF devices can have monopolar, bipolar, or multipolar configurations, differing in electrode arrangement and energy delivery method [7]. The latest generation of RF technology employs multiple RF generators with controlled phase, allowing precise energy delivery to the dermal and subcutaneous tissues [8]. The most commonly used devices include Secret RF, Infini, Morpheus8, Vivace, and Sylfirm X. RF microneedling devices may utilize:

- Insulated needles – delivering energy only at the tip, protecting superficial skin layers.
- Non-insulated needles – emitting RF along the entire needle length, providing more aggressive but less selective treatment.
- Pulsed or continuous modes – depending on the treatment protocol and clinical indication.

RF microneedling combines radiofrequency energy with microneedling, allowing deeper penetration and more targeted treatment [9]. Key treatment parameters include frequency, waveform, power, pulse duration, and penetration depth [10]. Parameters are individually tailored and typically include:

- Penetration depth (e.g. 0.5–2.0 mm in the periocular region).
- Energy power (commonly 5–25 W).
- Pulse duration (20–100 ms).
- Number of passes and repetitions per session.

Periocular treatment are usually performed under local anaesthesia (e.g. lidocaine cream), with particular caution near the eye surface [9, 10].

CLINICAL OUTCOMES AND SAFETY

RF microneedling treatment is well tolerated and demonstrate high efficacy in improving skin quality in the periocular region. Clinical effects are gradual, typically emerging within 2–4 weeks and becoming more pronounced over subsequent months (fig. 1). Studies report significant improvements in skin tightening, wrinkle reduction, and overall skin appearance. RF microneedling increases levels of type I and III collagen, contributing to measurable clinical outcomes.

Patients report high satisfaction rates and minimal discomfort during the procedure. The treatment is generally well tolerated, with a low incidence of adverse effects, making it suitable for various skin types (fig. 2). Post-inflammatory hyperpigmentation may occur; however, it is usually transient and reversible with appropriate clinical management.

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FIGURE 1

Patient before and 5 months after microneedle radiofrequency treatment, showing improvement in facial skin tone and firmness.



FIGURE 2

Patient undergoing microneedle radiofrequency treatment, with the device tip visible; erythema and pinpoint bleeding can be observed.



CONTRAINDICATIONS AND POTENTIAL COMPLICATIONS

RF microneedling is a minimally invasive aesthetic procedure that can effectively support the treatment of various dermatological conditions. Although generally considered safe, it is associated with certain contraindications and potential complications.

Contraindications include:

- Pregnancy and breastfeeding.
- Active skin infections (bacterial, viral, or fungal).
- Autoimmune skin diseases (e.g. lupus erythematosus).
- Skin malignancies and precancerous lesions.
- Coagulation disorders.
- Presence of metal implants or a cardiac pacemaker in the treatment area (in patients with pacemakers, the risk of thrombotic complications requires careful monitoring and consideration of anticoagulant therapy).
- Predisposition to keloid formation.

Potential complications include:

- Transient erythema (fig. 3), edema, and pruritus.
- Pinpoint bleeding or microcrusting.
- Post-inflammatory hyperpigmentation (especially with excessive treatment parameters).
- Skin infections (rare, typically associated with inadequate post-procedure care).
- Temporary sensations of tingling or numbness.

FIGURE 3

Patient after microneedle radiofrequency treatment with visible erythema persisting for several days.



Appropriate patient selection, practitioner experience, and adherence to aseptic techniques are essential for minimizing the risk of complications in these procedures [11, 12].

ALTERNATIVE TREATMENT MODALITIES

RF microneedling demonstrates high efficacy in improving eyelid skin firmness with minimal invasiveness. By combining microneedling with controlled thermal stimulation, it promotes collagen remodeling without damaging the epidermis.

Fractional CO_2 laser therapy is characterized by an intensive ablative effect, which may yield significant clinical improvement in patients with moderate to severe skin laxity; however, is associated with longer recovery time. Surgical blepharoplasty remains the most effective intervention,

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particularly in cases of anatomical eyelid ptosis and substantial excess skin.

High-intensity focused ultrasound (HIFU) and plasma-based treatment are non-invasive techniques that can be effective in mild to moderate skin laxity, although the results are often more subtle and may require repeated sessions. Dermal fillers and mesotherapy serve primarily as adjunctive treatments, improving skin quality, hydration, and tone, but do not address excess skin.

In terms of safety, minimally invasive techniques such as mesotherapy, RF microneedling, and HIFU are associated with the lowest risk profiles. Laser and plasma-based treatments carry a higher risk of post-inflammatory hyperpigmentation and excessive epidermal damage. Although highly effective, blepharoplasty is associated with potential complications, including asymmetry, scarring, and sensory disturbances of the eyelid (tab. 1).

CONCLUSIONS

RF microneedling represents an effective and safe method for reducing upper eyelid skin laxity. Through the synergistic action of microneedles and radiofrequency energy, it enables deep dermal stimulation without disrupting the integrity of the epidermis. This approach results in a significant improvement in skin firmness and tension in the periocular area, with minimal risk of complications and a short recovery period.

Comparative analysis with other modalities indicates that RF microneedling occupies an intermediate position between non-invasive and surgical techniques – offering outcomes comparable to fractional CO_2 laser and plasma-based treatments, but with lower risk and reduced invasiveness. In comparison with blepharoplasty, RF microneedling is less effective in cases of severe skin laxity or anatomical eyelid ptosis; however, it offers advantages in terms of patient comfort, accessibility, and safety.

TABLE 1

Comparison of methods for the reduction of upper eyelid skin laxity.

Method	Effectiveness	Invasiveness	Recovery time	Complications	Duration of effect
Surgical blepharoplasty	+++++	high	10–14 days	moderate	5–10 years
Microneedle RF	++++	low	1–3 days	low	1–2 years
Fractional CO_2 laser	++++	moderate	5–7 days	moderate	1–2 years
HIFU	++	low	0–2 days	low	6–12 months
Plasma	++	low	3–7 days	low	6–12 months
Mesotherapy	+	very low	0–1 days	minimal	3–6 months

HIFU – high-intensity focused ultrasound; RF – radiofrequency.

In summary, blepharoplasty remains the most effective option for patients with advanced skin laxity and excess tissue, providing durable and pronounced results, albeit with an invasive approach. RF microneedling offers the most favourable balance between efficacy and safety among non-surgical techniques, achieving outcomes comparable to laser treatments with shorter recovery time.

HIFU and plasma-based therapies represent suitable alternatives for patients unwilling to undergo surgery, particularly in cases of moderate eyelid laxity. Mesotherapy and dermal fillers primarily serve supportive roles, enhancing skin quality without addressing excess tissue.

Surgical blepharoplasty remains the gold standard for patients with significant excess of skin. Nevertheless, advances in modern technologies such as RF microneedling provide a viable alternative for individuals seeking less invasive solutions. RF microneedling is distinguished by a favourable safety profile, the ability to precisely treat delicate periocular areas, low invasiveness, and the absence of significant seasonal limitations, making it an attractive option for both patients and practitioners.

The choice of treatment for eyelid laxity should be individualized, taking into account the degree of skin sagging, patient expectations, willingness to undergo invasive procedures, and any medical contraindications.

Figures: from authors' own materials.

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