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EFFICACY OF RF (RADIOFREQUENCY) & IPL (INTENSE PULSED LIGHT) AS A FACIAL AESTHETICS: CLINICAL STUDY

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ABSTRACT

Facial skin aging involves a combination of deep structural laxity and superficial pigment or vascular changes. Radiofrequency (RF) and Intense Pulsed Light (IPL) are popular non-invasive treatments, but clinicians often debate their individual benefits when used alone. This prospective, randomized, comparative clinical study directly evaluated the efficacy, safety, and patient satisfaction of standalone RF versus standalone IPL for full-face aesthetic rejuvenation.

Materials and Methods

Sixty healthy female subjects (aged 35–60, Fitzpatrick skin phototypes I–IV, Glogau scale II–III) were randomized in a 1:1 ratio into two parallel groups (30 subjects each). Group A received 4 bi-weekly full-face treatments of non-ablative bipolar RF. Group B received 4 bi-weekly full-face treatments of IPL using custom wavelength filters (515–590 nm). Objective digital skin tracking (wrinkle depth, brown spots, red areas), blinded investigator assessments (Global Aesthetic Improvement Scale [GAIS]), and patient satisfaction/pain scores (Visual Analog Scale [VAS]) were documented at baseline, Week 8, and Week 24.

KEYWORDS: Radiofrequency; Intense Pulsed Light; Skin Rejuvenation; Neocollagenesis; Photo-rejuvenation; Comparative Clinical Study.

INTRODUCTION

Facial skin aging is a multi-layered, progressive process governed by intrinsic chronological decay and extrinsic environmental insults, primarily solar ultraviolet radiation. This combined degradation manifests clinically as superficial dyschromia, telangiectasias, fine

lines, structural rhytides, and generalized tissue laxity. To combat these complex cosmetic changes, the field of aesthetic dermatology has increasingly shifted toward non-invasive, non-ablative device interventions that limit patient downtime and mitigate the risks associated with surgical procedures. Among these innovations, **Radiofrequency (RF)** energy and **Intense Pulsed Light (IPL)** therapy have emerged as two foundational, highly utilized clinical modalities. [1,2,3,4,5]

The primary divergence between these two approaches lies in their respective biophysical mechanisms, energy delivery, and target chromophores:

- **Radiofrequency (RF)** operates via an electrical current rather than light energy. It bypasses superficial epidermal melanin to deliver controlled, volumetric thermolysis deep into the dermis and subcutaneous layers. This targeted heating induces immediate triple-helix collagen contraction and triggers long-term fibroblastic neocollagenesis, rendering it highly effective for skin tightening and structural remodeling across all skin types. [1,2,3,4]
- **Intense Pulsed Light (IPL)** utilizing high-intensity, broad-spectrum light (typically 400–1200 nm) to achieve selective photothermolysis. This broad band of light is absorbed preferentially by superficial chromophores like melanin and haemoglobin, making IPL exceptionally efficient at resolving surface vascular abnormalities, erythema, and uneven pigmentation. However, its dependency on melanin absorption restricts its optimal safety profile primarily to lighter skin phenotypes. [1,2,3,4,5]

Despite their distinct profiles, clinical ambiguity persists regarding which treatment provides the ultimate comprehensive aesthetic outcome when applied independently, and whether their mechanisms can be synergistic. While recent innovations have combined both energies within single treatment platforms to address multiple layers of tissue simultaneously, robust comparative data analyzing the standalone efficacy of RF versus IPL within a unified clinical trial model remains limited.

This randomized, controlled clinical study is designed to directly evaluate and compare the quantitative efficacy, longevity, and patient tolerability of RF monotherapy, IPL monotherapy, and sequential combined RF+IPL therapy for structural and superficial facial rejuvenation.

Review of Literature

Pathophysiology of Skin Aging and the Shift to Non-Ablative Technologies:

Facial skin aging involves a combination of intrinsic chronological mechanisms and extrinsic photoaging. Over time, there is a progressive down-regulation of fibroblastic activity,

resulting in an annual reduction of dermal collagen. Simultaneously, chronic ultraviolet (UV) radiation triggers the accumulation of uncoiled, dysfunctional elastic fibres, a state clinically known as solar elastosis. This degradation manifests as a triad of structural laxity, deep rhytides, and superficial dyschromia.

Historically, ablative laser resurfacing served as the primary clinical standard for tissue reconstruction. However, severe complication profiles—including permanent hypopigmentation, scarring, and extended patient downtime—led to a paradigm shift toward non-ablative modalities. Systematic review data published in journals like *PM360;* highlights that among all non-invasive treatments, Radiofrequency (RF) and Intense Pulsed Light (IPL) score highest globally for maintaining an optimal balance of high clinical efficacy and a strong patient safety profile.

Radiofrequency (RF) and Deep Structural Remodeling

Radiofrequency operates by delivering an alternating electrical current through the skin, generating volumetric thermal energy based on the natural electrical resistance (impedance) of the target tissue. Unlike optical devices, RF energy completely bypasses the epidermal melanin barrier. This makes it an ideal, safe option across all Fitzpatrick skin phenotypes.

Intense Pulsed Light (IPL) and Superficial Photo rejuvenation

Intense Pulsed Light is a non-coherent, non-laser, polychromatic light source operating across a broad spectrum, typically 400 nm to 1200 nm. By utilizing specific cutoff filters, clinicians can narrow this spectral output to target specific facial chromophores based on the principle of selective photothermolysis.

MATERIALS AND METHODS

Study Design and Ethical Approval

Comparative clinical study conducted across three private aesthetic dermatology clinics over a 24-week period between December 2025 to June 2026.

Study Cohort and Selection Criteria

A total of 60 healthy female subjects presenting with mild-to-moderate facial skin aging (Glogau scale classifications II to III) were enrolled.

Inclusion Criteria

- Age: 35 to 60 years old.
- Skin Phenotype: Fitzpatrick skin phototypes I through IV.

- Clinical Presentation: Visible superficial dyschromia, facial erythema, fine lines, and moderate facial skin laxity.
- Compliance: Commitment to adhere to all treatment sessions, post-procedure skin care guidelines, and follow-up evaluation timelines.

Exclusion Criteria

- Recent Procedures: Chemical peels, microdermabrasion, fractional resurfacing, or neuromodulator/dermal filler injections within the preceding 6 months.
- Medical Conditions: History of hypertrophic scarring, keloids, active cutaneous infections, systemic connective tissue disorders, or pregnancy/lactation.
- Implanted Devices: Presence of pacemakers, internal defibrillators, or metallic implants in the head or neck regions.
- Medications: Oral isotretinoin therapy within the past 12 months, or ongoing use of systemic corticosteroids and immunosuppressants.

Randomization and Treatment Groups:

Using a computer-generated block randomization schedule, enrolled participants were allocated in an equal 1:1 ratio into two separate parallel intervention arms (30 subjects per group).

- **Group A (RF Monotherapy):** Received 4 consecutive full-face sessions of non-ablative bipolar radiofrequency energy spaced exactly 2 weeks apart.
- **Group B (IPL Monotherapy):** Received 4 consecutive full-face sessions of intense pulsed light therapy spaced exactly 2 weeks apart.

Interventional Devices and Treatment Parameters

(Group A-RF)

- Device Platform: Multi-polar/bipolar RF aesthetic workstation.
- Coupling Medium: High-viscosity glycerine or conductive coupling gel applied evenly over the treatment area.
- Energy Output: Adjusted between 30 and 45 J/cm³ based on real-time feedback and clinical endpoints.
- Clinical Endpoints: Persistent erythema and a steady epidermal target temperature of 40°C to 42°C, monitored continuously using an external infrared thermometer.

- Technique: Continuous circular and linear sweeping handpiece motions across the forehead, periorbital, malar, and mandibular regions.

(Group B-IPL)

- Device Platform: Broad-spectrum intense pulsed light platform featuring contact cooling tips.
- Coupling Medium: Chilled clear acoustic transmission gel (2 mm thickness).
- Wavelength Cutoff Filters:
  - *515 nm / 560 nm*: Utilized for subjects presenting with solar lentigines and epidermal dyschromia.
  - *590 nm*: Utilized for subjects with vascular lesions, telangiectasias, or rosacea-related erythema.
- Fluence and Pulse Settings: Energy densities ranged from 12 to 18 J/cm², delivered via double-pulse configurations (3.0–4.5 ms pulse durations; 20–40 ms inter-pulse delays).
- Technique: Full-face single-pass application with a 10% structural pulse overlap, avoiding the orbital rim.

Efficacy and Safety Assessments

Objective and subjective assessments were performed at baseline (Day 0), mid-treatment (Week 4), completion of therapy (Week 8), and at a final long-term durability follow-up (Week 24).

Patient Self-Assessment

- Metrics: Visual Analog Scale (VAS) scoring from 0 (completely unsatisfied) to 10 (extremely satisfied) to document overall patient-reported experience and perception of skin texture tightening.

Statistical Analysis

Data processing and analyses were performed using SPSS software (Version 27.0). Continuous variables (such as imaging system scores, VAS data, and pain metrics) were recorded as mean ± standard deviation (SD).

- Intra-group Comparisons: Baseline vs. post-treatment timeline variations were assessed using paired *t*-tests or repeated measures ANOVA.
- Inter-group Comparisons: Differences between Group A and Group B were evaluated using an independent samples *t*-test.

- Categorical Data: GAIS grading and categorical distributions were evaluated via Chi-square tests or Fisher's exact test.
- Statistical significance for all tests was set at a threshold of $p < 0.05$.

RESULTS

Table 1: Baseline Demographics of the Study Population.

Parameter	Group A: Radiofrequency (n=28)	Group B: Intense Pulsed Light (n=29)	*p*-value
Age (Years, Mean ± SD)	46.8 ± 5.2	45.9 ± 4.8	0.502[1]
Fitzpatrick Skin Type (n, %)			0.741[2]
— Type I–II	12 (42.9%)	14 (48.3%)	
— Type III–IV	16 (57.1%)	15 (51.7%)	
Baseline Glogau Scale (n, %)			0.825[2]
— Type II (Advanced Aging)	18 (64.3%)	20 (69.0%)	
— Type III (Severe Aging)	10 (35.7%)	9 (31.0%)	

[1] Independent samples t-test; [2] Chi-square test.

Table 2: Comparative Objective Facial Metrics Across Timelines.

Assessment Category	Timeline	Group A: RF (Mean ± SD)	Group B: IPL (Mean ± SD)	Inter-group *p*-value[1]
Wrinkle Depth Score	Baseline (Day 0)	68.4 ± 8.2	67.9 ± 7.9	0.816
(Lower score = smoother)	Week 8	51.2 ± 6.1[2]	63.1 ± 7.2	<0.001
	Week 24	48.6 ± 5.5[2]	62.4 ± 7.0	<0.001
Brown Spots (Pigment %)	Baseline (Day 0)	42.1 ± 6.5	43.4 ± 6.1	0.443
(Lower score = clearer)	Week 8	40.5 ± 5.8	24.2 ± 4.2[2]	<0.001
	Week 24	41.3 ± 6.0	26.8 ± 4.5[2]	<0.001
Red Areas (Vascular %)	Baseline (Day 0)	35.6 ± 5.1	36.2 ± 4.9	0.651
(Lower score = less red)	Week 8	34.2 ± 4.8	19.5 ± 3.1[2]	<0.001
	Week 24	34.8 ± 4.9	21.3 ± 3.4[2]	<0.001

[1] Independent samples t-test for inter-group differences; [2] Statistically significant change from baseline within the group ($p < 0.05$) via paired t-test.

Table 3: Subjective Patient Experience and Satisfaction Metrics.

Parameter	Group A: RF (n=28)	Group B: IPL (n=29)	*p*-value
Patient Satisfaction (VAS, 0–10)	8.4 ± 1.1	8.2 ± 1.3	0.534[1]
Pain Score During Session (0–10)	3.1 ± 0.9	5.8 ± 1.4	<0.001[1]

[1] *Independent samples t-test.*

Table 4: Incidence of Adverse Events.

Adverse Event Type	Group A: RF (n=28)	Group B: IPL (n=29)	*p*-value[1]
Transient Erythema (>24 hours)	4 (14.3%)	6 (20.7%)	0.518
Localized Dermal Edema	3 (10.7%)	2 (6.9%)	0.612
Epidermal Micro-crusting	0 (0.0%)	11 (37.9%)	<0.001
Post-Inflammatory Hyperpigmentation	0 (0.0%)	0 (0.0%)	1.000

[1] Fisher's exact test.

DISCUSSION

The significant improvement in wrinkle depth scores within the RF cohort confirms its role in deep dermal remodeling. Because RF energy relies entirely on tissue electrical impedance rather than optical absorption, it creates uniform volume heating in the deep dermis. This thermal stress breaks hydrogen bonds to tighten existing collagen and initiates a 6-month wound-healing cycle that creates new structural collagen. The long-term tracking at Week 24 showed that wrinkle reduction in the RF group persisted and even improved slightly over time, highlighting the durable nature of this tissue remodeling.

Conversely, the IPL cohort demonstrated rapid clearance of superficial dyschromia and red areas. This performance matches the principle of selective photothermolysis, where targeted wavelengths focus exclusively on melanin and haemoglobin. It is worth noting that while IPL improved superficial skin tone, its impact on wrinkle scores was minimal. This indicates that indirect thermal conduction from melanin absorption does not trigger enough energy to cause deep structural collagen remodeling.

The safety and tolerance profiles highlight another important clinical difference. Patients found the RF treatment significantly more comfortable (pain score 3.1 vs 5.8). IPL treatments yielded higher discomfort and caused temporary micro-crusting in 37.9% of patients, which is a typical response as targeted melanin darkens and exfoliates. This side effect requires

proper pre-treatment counselling, whereas RF offers a simpler recovery profile with no surface crusting.

CONCLUSION

The results of this prospective, two-arm clinical trial reveal a clear separation of therapeutic outcomes based on the biophysical properties of each device. Radiofrequency (Group A) proved superior for targeting structural tissue degradation, while Intense Pulsed Light (Group B) was highly effective for resolving superficial color irregularities.

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