Efficacy of Synchronous Delivery of Radiofrequency and Targeted Ultrasound for the Facial Hydration and Rejuvenation in Asians

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Abstract

Skin aging results in deteriorated hydration and rejuvenation, influenced by internal and external factors. It remains a common concern affecting quality of life and growing demand for non-invasive procedures with minimal downtime, fewer side effects, and natural outcomes. While radiofrequency is well established for stimulating neocollagenesis and neoelastogenesis, its role in enhancing hydration is less explored. Additionally, combining radiofrequency with targeted ultrasound has gained attention for improving treatment efficacy while minimizing limitations of single-modality approaches. This prospective single-arm study evaluated the efficacy and safety of synchronous monopolar radiofrequency and targeted ultrasound for improving skin hydration and facial rejuvenation in Asian skin types (Fitzpatrick III–V). A total of 27 participants (aged 25–60) received weekly full-face treatments over four weeks. Clinical outcomes were assessed at baseline, 1-month, and 3-month follow-ups using Moisture Meter (hydration), TEWL Meter (epidermal water loss), Mexameter (melanin and erythema), and Antera 3D (wrinkle, texture, pores). Histological evaluations were performed in a subset of participants. Results demonstrated that Moisture levels increased significantly by 4.7% ($p < 0.001$). Wrinkle depth decreased significantly in both lower and upper cheek areas by 8.7% and 8.5% ($p = 0.049$ and 0.046, respectively), reflecting skin tightening. Although texture, pore, and Mexameter parameters did not reach statistical significance, they showed positive trends. No severe adverse events were reported. Together, these findings suggest that the treatment improves key aspects of skin remodeling, supporting its rejuvenating effect in Asian skin types. This abstract presents interim findings based on 1-month follow-up data. Full 3-month results are pending.

Keywords**:** *synchronous delivery of radiofrequency and targeted ultrasound, facial hydration, facial rejuvenation, asians, skin aging*

1. Introduction

Skin aging is a natural process that occurs with age, whose exact mechanisms remain unclear and multifactorial in influence including intrinsic and extrinsic factors such as genetic, aging, hormone and cumulative exposure to ultraviolet radiation, which impact on patients' confidence and quality of life. It then depletes in collagen, elastin, hyaluronic acid and sulphated GAGs lead to worsen of skin texture, tightening, pigment, thickness and hydration. Currently, the treatment is ranging from non-invasive to minimally-invasive procedures including lasers therapy, microdermabrasion, chemical peels, topical application, injections, and energy-based device such as radiofrequency and ultrasound. Among these, radiofrequency has gained a lot of attention, and it still has its own advantages and disadvantages. So, the new innovation is invented looking for better improvement while reducing the old limits of existing technology, patients' comfort, user-friendly, non-invasive, less downtime, fewer operative complications, and a natural method. (Galvez-Martin et al., 2023)

The radiofrequency is a widely used energy-based modality in dermatology that delivers heat into the dermis to stimulate neo collagenesis, and tissue tightening. Monopolar RF, in particular, penetrates deeper into the dermis than bipolar RF, making it suitable for treating deeper signs of aging with fewer complications (Rohrich et al., 2022)

Focusing on skin hydration and epidermal barrier, Bipolar RF is more effective than monopolar RF, particularly for middle-aged women, while Monopolar RF showed diminishing benefits, especially in younger and older participants. (Stochaj et al., 2022)

However, their ability to improve skin hydration remains limited. In contrast, targeted ultrasound employs focused mechanical and thermal energy to stimulate fibroblasts, enhance extracellular matrix remodeling, and promote HA synthesis. Both modalities offer distinct benefits, yet each has inherent limitations when used alone. (Duncan et al., 2024).

Recent studies have suggested that combining radiofrequency and targeted ultrasound produces synergistic effects by simultaneously delivering thermal and mechanical energy to the dermis. This synchronous delivery has been shown in preclinical models to increase the expression of HA-synthesizing enzymes (HAS1, HAS2, HAS3), upregulate CD44 (a key HA receptor), and activate pathways involved in ECM remodeling via TGF-β and FGF1. The histological also shows evidence of increased HA in the extracellular matrix via confocal microscopy. These findings support the hypothesis that radiofrequency and targeted ultrasound, when delivered together, may enhance hydration and skin rejuvenation more effectively than either modality alone. (Duncan et al., 2024).

A recent clinical study demonstrated that synchronous monopolar radiofrequency and targeted ultrasound significantly enhances skin hydration, texture, long-term skin quality, and patient satisfaction compared to monopolar RF alone, which was controlled by undergoing four full-face treatments, once per week. This study primarily focused on individuals with fair to medium skin tones (Fitzpatrick types 1-2), comprising 15 participants. In contrast, the number of participants with darker skin tones (Fitzpatrick types 3, 4, and 5) was limited to only 3, 2, and 1, respectively, highlighting a limitation in studying individuals with darker skin. (Boyd, & Chilukuri, 2024)

Asian skin, predominantly Fitzpatrick skin types III to V, has unique characteristics including higher melanin content, increased sensitivity to inflammation, and a higher risk of post-inflammatory hyperpigmentation. These features justify the need to evaluate the safety and efficacy of energy-based devices specifically in this population.

To date, there is limited clinical evidence investigating the effects of synchronous monopolar RF and TUS in Asian patients. Therefore, this study aims to assess the efficacy and safety of this combined modality for improving skin hydration and facial rejuvenation in Asian individuals, particularly Fitzpatrick types 3-5. We hypothesize that synchronous delivery of monopolar RF and targeted ultrasound will lead to significant improvements in both skin hydration and rejuvenation with a favorable safety profile in darker skin types. The procedure was performed once a week for four weeks. Evaluations included objective and subjective assessments at baseline, 1-month, and 3-month follow-ups.

2. Objectives

1) To evaluate the efficacy of synchronous delivery of radiofrequency and targeted ultrasound for skin hydration in Asians via the Moisture Meter and TEWL.
2) To evaluate the efficacy of synchronous delivery of radiofrequency and targeted ultrasound for skin rejuvenation in Asians via Antera3D and Mexameter.
3) To assess the adverse effects of synchronous delivery of radiofrequency and targeted ultrasound in Asians.

3. Materials and Methods

The prospective, single-arm study was conducted at the Dermatology Department of Benchakitti Park Hospital, Bangkok, Thailand, without a control group.

3.1 Participants and Study Design

A total of 29 participants aged 25–60 years with Fitzpatrick skin types III–V were enrolled. Participants were recruited through on-site poster advertisements and online announcements. The sample size was determined based on feasibility and reference to prior pilot studies using similar energy-based treatment

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protocols. All participants provided written informed consent prior to enrollment. The IRB approved the study protocol.

3.2 Inclusion criteria

1) Participants aged 25 - 60 years old
2) Fitzpatrick skin type III-V
3) Participants who voluntarily submitted written consent

3.3 Exclusion criteria

1) Patient who has received any facial treatment in the last 6 months including any oral retinal derivative facial injection, LASER, LED light therapy, and topical derivative of chemical peeling or bleaching agents (retinol derivative, azelaic acid, hydroquinone, monobenzyl ether of hydroquinone, glycolic acid, α-hydroxy acids, trichloroacetic acid, phenol)
2) Patient with permanent metal equipment or medical device implantation within the face and the adjacent area
3) Patient with implantation of a Pacemaker or any electrical stimulation in the body
4) Patient with an active skin wound or local infection in the treatment area
5) Patient with current pregnancy, lactating women or planning to become pregnant in the recent 6 months
6) Patient with unrealistic expectations

3.4 Equipment

The synchronous delivery of radiofrequency and targeted ultrasound (EXION™; BTL Aesthetic Ltd., Newcastle, England) with a FACE applicator (0.5 cm^2 tip) was used. The Monopolar Radiofrequency utilized homogenous heats across the entire dermis to a temperature range of 40-42°C and delivers 3.25 MHz with RF percentage depending on the treated sites. The targeted ultrasound directed mechanical waves to the reticular dermis and heated up to 42°C, which delivered up to 1.9 MHz, as measured by the skin impedance.

3.5 Study methods

3.5.1 Preoperative

1) All patients' faces were restrained from applying any makeup, cream, or washing product two hours prior to the day of the appointment, and were not to excessively apply skin care before the day of follow-up in order to control the influence of environmental factors on the study.
2) They were instructed to rest in the test room for at least 30 minutes in order to calm the blood circulation and skin perspiration in a controlled 22-27°c temperature and relative humidity of 52-62% at latitude and longitude (13.7242843 N, 100.5539138) by temperature and humidity meter.
3) They were wiped with dry tissue gently before the test to remove excess sweat or oiliness.
4) They were instructed to remove all metallic accessories
5) They were taken by digital camera using identical camera settings, lighting, and patient positioning with frontal, left-oblique, right oblique, left-lateral, and right-lateral views
6) They were measured with MoistureMeter-D, TEWAmeter®, Mexameter® and Antera3D®, which were obtained at baseline, 1-month follow-up after treatment and 3-month follow-up after treatment
7) In case of voluntary skin biopsy, they were requested to take a skin biopsy two times, before starting the treatment at baseline and three months after the last treatment session. The selected site of biopsy is assessed by the right jawline along the relaxing skin tension line. The selected site and adjacent areas were prepped and draped in aseptic technique before beginning the procedure, and 2% xylocaine with adrenaline 1 ml was injected intradermally at the selected area. Punch biopsy is then performed with a diameter of 2 mm over the lesion and rolling perpendicularly through the skin until there is a decrease in tension. They are preserved in formaldehyde solution. Then, the samples are sent to be stained with the Masson Trichome, Verhoeff-Van Gieson and Alcian blue stain by laboratory experts. The wound was

closed with non-absorbable material 5-0 by simple interrupted sutures, and dressing wounds were done properly with water-resistant materials occluded. The appointment was followed up and stitched off at day 7. All patients are advised to take care of their wound properly, including avoiding contact with any water or opening of the wound before the day of follow-up. If they confront any problems, they are advised to see a doctor before making an appointment.

3.5.2 In operative

1) The tip membrane was disinfected with 70% isopropyl alcohol, and the condition was checked with an appropriately positioned, grounded.

2) The coupling gel was applied to the treatment area to ensure uniform conduction of energy from the tip electrode to the skin.

3) The return pad was attached to the right side of the upper back.

4) The treatment was commenced under the machine-controlled pressure, temperature sensors, and skin-impedance checking in the tip, which automatically aborted energy delivery if uniform contact was not maintained with the skin or if the temperature at the skin surface rose above a set threshold.

5) The treatment started with the test shot at the standard level of each area by using the minimum range with adjusted for each 5% to reach the targeted temperature which appeared on the monitor.

6) The energy level was then varied according to patient feedback, which thermal sensation goal was a score of 3 (from 0 to 10) “hot but tolerable”.

7) All patients were treated with synchronous delivery of radiofrequency and targeted ultrasound (EXION^{TM}; BTL Aesthetic Ltd., Newcastle, England) with FACE applicators for 34 minutes according to program recommendation. The treatment times for one side of the forehead, upper cheek, and lower cheek are 5, 6, and 6 minutes, respectively. The RF percentages of forehead, upper cheek, and lower cheek were 65-75, 65-75 and 75-85, respectively by using the minimum range, adjusted for each 5% to reach the targeted temperature, which appeared in the monitor.

8) The tip was applied circularly repeatedly in every aspect of each area zone, and it was kept perpendicular to the skin to ensure that the tip fully contacted the skin.

9) All enrolled subjects received the same treatment procedure every week for 1 month.

3.5.3 Post-operative

1) All patients were advised to perform photoprotection properly, including physical and topical protection by applying UVA/B sunscreen with SPF >30 daily and avoiding direct sun exposure

2) All patient can continue their regular skincare routine at home, and current supplementary products without worrying about negative effects. But, no other supplementary products or special instructions on skin care were taken

3) All patients were advised to avoid anti-inflammatory medications (steroid and non-steroid) in order to maximize the healing response

4) All patient were restrained from any facial treatment during enrolled the project including any oral retinal derivative, facial injection, LASER, LED light therapy, and topical derivative of chemical peeling or bleaching agents (retinol derivative, azelaic acid, hydroquinone, monobenzyl ether of hydroquinone, glycolic acid, α-hydroxy acids, trichloroacetic acid, phenol)

3.6 Assessment

As this study is ongoing, only 1-month follow-up data are presented in this proceedings version. Full follow-up data, including the 3-month outcomes, will be included in the final publication.

3.6.1 Subjective evaluation

1) Patient satisfaction score: the volunteers evaluated the satisfaction of skin hydration, skin texture, skin tightening, skin color improvement at baseline and 3-month follow-up by Likert scale which is a 1 to 5 score. The value of each topic’s score is:

- 1 defined as Not at all satisfied
- 2 defined as Not really satisfied
- 3 defined as Undecided
- 4 defined as somewhat satisfied
- 5 defined as Very satisfied

2) The adverse effects were recorded during the treatment and participants evaluated the pain score at 3 month follow up by using visual analog scale. The value of each score is:

- 0 defined as No pain
- 1 defined as Mild pain (1-3)
- 2 defined as Moderate pain (4-5)
- 3 defined as Severe pain (5-6)
- 4 defined as Very severe pain (7-9)
- 5 defined as Worst pain possible (10)

3.6.2 Objective evaluation

1) TEWLmeter was used to evaluate skin hydration by the transepidermal water loss which epidermis hydration increase accompanied with TEWA decrease. The measuring was controlled with averaged temperature and relative humidity, and measured both the left and right sides at the following spot: the intersection of the vertical and horizontal line, which the vertical line is the lateral canthus and the horizontal line is a line from angular oris to the ear lobule

2) A moisture meter was used to evaluate skin hydration by tissue water content in biological tissues. The probe S was used for measure depth of 1.5 mm down to 3 both left and right side at the following spot: the intersection of vertical and horizontal line which horizontal line is zygoma bone and vertical line is (1) mid-pupil (2) lateral canthus (3) far from (2) for 2 cm in horizontal. Each point was measured three times to calculate average values for accuracy

3) Mexameter was used to evaluate skin color; melanin and erythema for left and right side at the following spot: the intersection of vertical and horizontal line, which horizontal line is the zygoma bone and the vertical line is (1) mid-pupil, (2) lateral canthus

4) Antera3D was used to evaluate skin rejuvenation in wrinkles, textures, and pores at left and right sides at the following spots: (1) lower cheek and (2) periorbital area – upper cheek. Then, Antera 3D™ software was used to analyze the images. The index of each variable was noted as a number and calculated to compare the change in the same area of each participant

5) Histologic evaluation was taken from a skin biopsy with voluntary consent. The selected site of biopsy is the right jawline along the relaxing skin tension line. They were preserved in formaldehyde solution and stained with Masson Trichome, Verhoeff-Van Gieson and Alcian blue stain by laboratory experts for collagen, elastin and hyaluronic acid assessment, respectively, by analyzing under a polarized microscope

3.7 Statistical analysis

Descriptive statistics were used to summarize the data, including mean and standard deviation (SD) for normally distributed continuous variables, median with range (min–max) for non-normally distributed continuous variables and ordinal data, and percentages for categorical variables. The normality of data distribution was assessed using the Shapiro-Wilk test.

To assess the effectiveness of the intervention, statistical differences in parameter values were analyzed between baseline and one month post-intervention, as well as between baseline and three months post-intervention. For normally distributed data, a paired Student's t-test was used, while for non-normally distributed data and ordinal variables, the Wilcoxon Signed Ranks Test was applied. A 95% confidence interval (95% CI) was used, and statistical significance was set at $P < 0.05$.

4. Results and Discussion

4.1 Results

4.1.1 Clinical results

The study included a total of 29 participants with a mean age of 44.9 ± 11.5 years (range: 27-60 years). Two subjects were withdrawn from the study because they could not attend the follow-up visit. Regarding gender distribution, 7 participants (25.9%) were male, while 20 participants (74.1%) were female. In terms of Fitzpatrick skin type classification, 13 participants (48.1%) had skin type III, 12 participants (44.4%) had skin type IV, and 2 participants (7.4%) had skin type V. For the pain score assessment, 16 participants (59.2%) reported no pain, 10 participants (37.0%) experienced mild pain, and 1 participant (3.7%) reported moderate pain. Demographic characteristics were summarized in Table 1.

4.1.2 Subjective results

As shown in Table 2, subjects' self-assessment was recorded at the baseline and 3-month follow up in each topic: skin hydration, skin texture, skin tightening and skin color improvement using Likert scale. The baseline was presented in Table 2. All parameters showed a median score of 2, which refers to not being satisfied in this population. Subjective evaluations at the 3-month follow-up are planned for future reporting in the complete study manuscript.

4.1.3 Objective results

Facial hydration (MoistureMeter, TEWL):

As shown in Table 3, Facial skin hydration, measured by the MoistureMeter, significantly increased from a baseline of 40.15 ± 3.54 % to 42.04 ± 3.52 % at 1 month post-treatment (p-value< 0.001), resulting in a rise of skin hydration by tissue water content.

The Tewametric assessment for skin hydration is associated with the transepidermal water loss process, where an increase in epidermis hydration is accompanied by a decrease in TEWL. The mean values of TEWL tend to decreasing from baseline 9.82±5.74 g/m²/h to 1 month 9.11±7.38 g/m²/h indicating hydration augmented but this change was not statistically significant (*p-value* 0.100).

Table 1 Patient demographics (n=27)

Variable	Value
Age (years), Mean ± SD	44.9 ± 11.5
(min-max)	(27-60)
Gender, N(%)	
Male	7 (25.9)
Female	20 (74.1)
Fitpatrick skin type, N(%)	
III	13 (48.1)
IV	12 (44.4)
V	2 (7.4)
Pain Score, N(%)	
No pain	16 (59.2)
Mild pain	10 (37.0)
Moderate pain	1 (3.7)

Table 2 Subjects' self-assessment degree of skin hydration, skin texture, skin tightening and skin color at baseline

Variable	Before
Skin hydration, Median (min-max)	2(1-4)
Skin texture, Median (min-max)	2(1-4)
Skin tightening, Median (min-max)	2(1-4)
Skin color, Median (min-max)	2(1-4)

Facial rejuvenation (Mexameter and Antera 3D):

As shown in Table 3, the Melanin index tend to minimally decrease from baseline 219.21±34.91 AU to 1 month 214.78±42.49 AU (*p-value* 0.304) and the Erythema index was prone to increasing in 1 month compared to baseline with 319.96±75.54 AU to 1 month 328.26±84 AU (*p-value* 0.208). However, neither change reached statistical significance.

As shown in Table 4 showed wrinkle, texture and pore volume and pore index in the Lower cheek area and Upper cheek area by using Antera3D. In the lower cheek region, the average wrinkle depth decreased from baseline 17.23±4.68 mm and 1 month 15.73±5.45 mm, representing a statistically significant improvement (p = 0.040). The average texture, pore volume and pore index also showed improvement trends, though these changes did not reach statistical significance at 1 month (p = 0.068, 0.086 and 0.086) respectively. Specifically, texture decreased from 18.38 ± 5.41 mm to 17.23 ± 7.82 mm, pore volume reduced from 2.25 ± 0.87 mm^3 to 1.97 ± 0.99 mm^3, and pore index improved from 7.14 ± 2.75 AU to 6.26 ± 3.13 AU

In the Upper cheek region, wrinkle depth similarly decreased with a statistically significant difference (p = 0.046) from baseline 15.76±5.09 mm and 1 month 14.42±4.07 mm. Improvements were also observed in texture, pore volume, and pore index, but these did not reach statistical significance at 1 month (p = 0.051, 0.087 and 0.099). For texture decreased from 16.72 ± 5.81 mm to 15.21 ± 4.67 mm, pore volume reduced from 2.02 ± 0.95 mm^3 to 1.78 ± 0.8 mm^3, and pore index improved from 6.43 ± 3.03 AU to 5.7 ± 2.6 AU.

As shown in Figure 1, this case presents a representative of a 49-year-old female patient who underwent four sessions of synchronous RF and TUS treatment. Post-treatment images at 1 month demonstrate visible improvements in wrinkle reduction, skin texture refinement, and pore minimization.

4.1.4 The side effect

During the treatment, the majority (96.3%) reported no pain to tolerated pain, ranging just level 1-3, and only 1 participant (3.7%) reported moderate pain 4-5. However, no patients were confronted with adverse effects such as dyspigmentation, textural alteration or burning. Most of them were dealt with mild erythema after treatment, and it spontaneously resolved in 24 hours.

Table 3 Skin biophysical parameters of TEWL, Moisture Meter, and Mexameter at Baseline and 1 month after the treatment

Variable	Baseline	1 month after the intervention	*P value*[1]
TEWL (g/m²/h)	9.82±5.74	9.11±7.38	0.100
Moisture meter (%)	40.15±3.54	42.04±3.52	<0.001*
Melanin (AU)	219.21±34.91	214.78±42.49	0.304
Erythema(AU)	319.96±75.54	328.26±84	0.208

P value[1]= comparison between baseline and 1 month

* = statistically significant

Table 4 Skin biophysical parameters of Antera3D at Baseline and 1 month after the treatment

Area	Variable	Baseline	1 month after the intervention	*P value*[1]
Lower Cheek	Wrinkle (mm)	17.23±4.68	15.73±5.45	0.049*
	Texture (mm)	18.38±5.41	17.23±7.82	0.068
	Pore volume (mm^3)	2.25±0.87	1.97±0.99	0.086
	Pore index (AU)	7.14±2.75	6.26±3.13	0.086
Upper cheek	Wrinkle (mm)	15.76±5.09	14.42±4.07	0.046*
	Texture (mm)	16.72±5.81	15.21±4.67	0.051
	Pore volume (mm^3)	2.02±0.95	1.78±0.8	0.087
	Pore index (AU)	6.43±3.03	5.7±2.6	0.099

P value[1]= comparison between baseline and 1 month

* = statistically significant

4.2 Discussion

Radiofrequency (RF) has long been widely used for addressing skin aging, yet previous studies have primarily focused on its effects on collagen and elastin remodeling rather than hydration, and have often excluded participants with medium-to-dark skin tones.

This study is novel in its focus on the combined use of synchronous monopolar RF and targeted ultrasound specifically for improving skin hydration and rejuvenation in Asian populations (Fitzpatrick skin types III–V), a group that is underrepresented in existing research. However, the pathophysiology of skin aging is multifactorial and complex, presenting a challenge in dermatological treatment. Common treatments include laser therapy, microdermabrasion, chemical peels, topical agents, injectables, and energy-based devices such as RF and ultrasound. Most of these target collagen and elastin production, while fewer focus on improving skin hydration. Aging contributes to the degradation of collagen, elastin, hyaluronic acid, and sulfated glycosaminoglycans (GAGs), collectively worsening skin quality in all aspects (Galvez-Martin et al., 2023).

Among RF modalities, bipolar RF has been associated with favorable facial rejuvenation outcomes and a lower risk of severe complications, though it may present a higher rate of minor side effects compared to monopolar RF. Despite its limitations, monopolar RF remains effective and holds potential for further development (Rohrich et al., 2022; Stochaj et al., 2022).

The novel invention has been launched with synchronous of monopolar radiofrequency and targeted ultrasound with breaking the limit of monopolar RF yet still augmented effects by targeted ultrasound. Also, it surpasses the constraint of less investigation in the skin hydration facet.

Monopolar radiofrequency induces heat bulging to the tissue by creating electrical currents that cause pass through the tissue and exits via a grounding electrode, causing intradermal heating subsequently remodeling of dermal structure by stimulating the fibroblasts to produce collagen, elastin, HA and ECM and the heat also causes tissue contraction, leading to immediate tightening effects. Targeted ultrasound utilizes high-frequency sound waves uses mechanical compression waves to stimulate tissue through both mechanical and thermal effects. Also, Targeted ultrasound is focused and concentrated. These create a more precise, targeted and deeper concentrated effect, reaching higher temperatures without harming the reticular dermis, where the most active fibroblasts are located. These fibroblasts are mechanically stimulated, leading to increased thermal effects and mild vibrations within the cells. It is believed that combining the heat and mechanical stress energize fibroblasts, triggering collagen, elastin and hyaluronic acid production. (Austin et al., 2022; Boyd & Chilukuri, 2024; Contini et al., 2023).

A previous study by Duncan et al. (2024) provided evidence that the integration of monopolar radiofrequency and targeted ultrasound is superior to the conventional use of either modality alone, especially in terms of improving skin hydration. It provokes since the enzyme process of synthetic synthase activation of HAS1, HAS2, HAS3 peaks at different times, ensuring a sustained increase in HA levels and upregulates expression of CD44, which is the key HA receptor to respond to higher HA levels. Also, it energizes extracellular matrix biosynthesis by elevated TGF-B1, which regulates ECM remodeling, and FGF1 boosts fibroblast proliferation function and skin regeneration. Likewise, Histological Confirmation by Confocal microscopy visualizes the enhanced HA deposition in the ECM which supporting the biochemical findings.Ṅ Additionally, RT-qPCR analysis and MALDI-TOF was inferred that low-molecular-weight HA is predominantly detected which is biologically active and plays a crucial role in wound healing, fibroblast migration, and endothelial cell activation. To conclude that, the presence of LMWHA may also account for the complex extracellular matrix (ECM) response, further supporting the regenerative potential of RF + TUS treatment.

The prior study of Boyd and Chilukuri (2024) suggests significantly improved skin hydration, texture, skin quality and patient satisfaction compared to monopolar RF alone but the study focused on fair to light skin tones FST I-II, highlights the need for more data in medium-to-darker skin tones.

Our study specifically addressed Fitzpatrick III–V, where skin tends to be more reactive and susceptible to post-inflammatory hyperpigmentation. In contrast to Boyd's study, our results also support the

efficacy and safety of radiofrequency and targeted ultrasound in darker skin tones, contributing novel clinical insights.

Results from our study showed significant improvements in hydration and wrinkle reduction at one month. Specifically, skin hydration increased from 40.15 ± 3.54 % to 42.04 ± 3.52% or increased by 4.7% ($p < 0.001$), and wrinkle depth significantly decreased by 8.7% and 8.5% in both lower and upper cheek areas ($p = 0.049$ and 0.046, respectively). Texture, pore volume, and pore index also showed favorable trends without statistical significance. These outcomes were consistent across upper and lower cheek regions, as measured by Moisture meter and Antera 3D. While TEWL and Mexameter parameters showed positive trends, they did not achieve statistical significance.

There are no reported adverse effects of dyspigmentation, textural alteration, or burning. Most participants only experienced mild erythema post-treatment, which resolved spontaneously within 24 hours. And, the majority (96.3%) reported no pain or tolerable pain-level 0 to 3, while only one participant FST5 (3.7%) reported moderate pain, ranging from 4 to 5, likely due to individual tolerance, as no anesthesia cream was applied in this study. The research utilized a qualitative pain scale meaning rather than a numeric score, which can vary depending on individual endurance and scoring. However, it can be inferred that the pain did not exceed a score of 5, even without anesthesia cream, indicating a good safety profile. Post-treatment subjective evaluations were not yet available at the time of this report.

Compared to the findings of Boyd and Chilukuri (2024), skin hydration increased by 22.8% immediately after the final treatment session. In contrast, our study assessed hydration at 1 month post-treatment and still demonstrated a statistically significant increase from 40.15 ± 3.54 % to 42.04 ± 3.52% or an increase of 4.7%, suggesting that the hydration effects of synchronous RF and TUS are not only immediate but also sustained beyond the treatment period. Although the percentage change in our study was smaller, the delayed measurement may reflect a more durable treatment effect rather than an acute response. These findings support the long-lasting hydrating potential of the combined modality, even in medium-to-darker Asian skin types. For skin texture, our Antera 3D data did not even reach statistical significance for skin texture improvements, the trend was consistent with Boyd et al. (2024), who observed significant improvement using QuantifiCare® (19.3%) at 1 month. This supports the modality's potential benefit across different populations and measurement tools.

While Boyd's study did not report detailed wrinkle depth analysis, our findings suggest a direct skin-tightening effect, which we interpret as a key component of facial rejuvenation. Additionally, although texture and pore parameters in our study did not reach statistical significance, they showed consistent trends toward improvement, further supporting the rejuvenating potential of synchronous RF and TUS. These objective outcomes, combined with the absence of adverse effects and high tolerability, reinforce the safety and efficacy of this combined modality in medium-to-darker Asian skin types—an underrepresented population in previous trials.

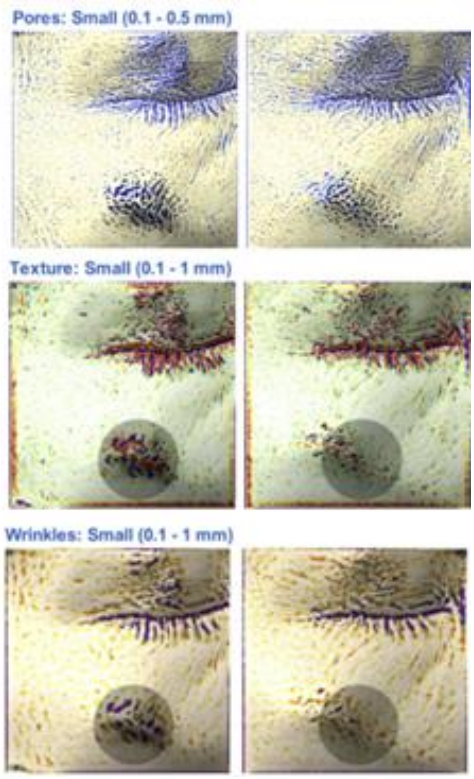

Figure 1 Representative before-and-after images of a 49-year-old female patient treated with four weekly sessions of synchronous monopolar radiofrequency (RF) and targeted ultrasound (TUS). The post-treatment image, taken at 1-month follow-up, demonstrates noticeable improvements in wrinkle reduction, smoother skin texture, and reduced pore visibility in the upper cheek area. Images were obtained under standardized lighting and positioning conditions. Baseline (left) and 1-month post-treatment (right).

Limitations include a small sample size, lack of randomization, no control group, and a short follow-up period, as only 1-month data were available at the time of this report, while 3-month follow-up data collection was still ongoing. These factors may limit the generalizability and strength of conclusions. Future research should employ randomized controlled trials with larger, more diverse populations and long-term follow-up to validate and extend these findings.

Hence, this study highlights a novel, non-invasive therapeutic approach warranting larger-scale clinical trials to confirm its efficacy and durability across diverse skin types by demonstrating significant wrinkle reduction and hydration improvement in Asian skin types III–V. While texture and pore refinement did not reach statistical significance, their positive trends suggest broader skin rejuvenation effects from monopolar radiofrequency and targeted ultrasound therapy in Asians with less pain sensitivity and no serious complications.

5. Conclusion

This study confirmed the efficacy of synchronous monopolar RF and targeted ultrasound in improving hydration and reducing wrinkles, indicating enhanced skin tightening. Although improvements in texture and pores were not statistically significant, the overall trends reflect positive skin remodeling and support the treatment's rejuvenating effect in Asian skin types III–V with a safety profile.

6. Acknowledgements

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7. References

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