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Multilayer Micro-pulsed High-Intensity Focused Ultrasound for Facial Laxity and Lower-Face Contouring: A Retrospective Study

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Abstract

Background

Focused ultrasound systems deliver acoustic energy to discrete targets at programmable depths, creating thermal coagulation points (TCPs) that trigger collagen remodeling and tissue contraction. Micro-pulsed high-intensity focused ultrasound (MP-HIFU) platforms deliver energy in segmented pulses to improve comfort and support multi-depth, multilayer protocols that can address both lifting of the superficial musculoaponeurotic system (SMAS) and superficial fascia and contouring of submental and submandibular fullness.

Objective

To describe a practical multilayer MP-HIFU protocol for full-face lifting and lower-face/submental contouring and to report investigator-rated Global Aesthetic Improvement Scale (GAIS) outcomes and objective three-dimensional (3D) volumetric changes in a 23-patient clinical series.

Methods

Twenty-three adults seeking nonsurgical lifting/contouring underwent a single-session multilayer MP-HIFU treatment using 1.5-6.0 mm focal depths in normal and micropulse modes, targeting superficial dermis through the SMAS and, when indicated, deeper subcutaneous fat in the submental/submandibular region. Outcomes included standardized photography and 3D imaging (LifeViz System; Quartier Latin SAS, Biot, France) with volumetric mapping and investigator-rated GAIS at weeks 12 and 24.

Results

At 12 weeks, 22 of 23 patients (95.7%) were rated as improved or better on investigator-rated GAIS. At 24 weeks, 21 of 23 patients (91.3%) were rated as improved or better. Selected 3D images illustrate individual changes in facial and submental appearance. No serious adverse events were reported in this series.

Conclusion

Multilayer MP-HIFU can provide simultaneous lifting and contouring effects across the face and submental/submandibular regions. GAIS reporting, together with objective 3D analysis, strengthens real-world evidence and supports reproducible treatment planning.

Categories: Plastic Surgery, Dermatology
Keywords: 3d imaging, facial fat, facial lifting, global aesthetic improvement scale, high-intensity focused ultrasound (hifu), jawline, microfocused ultrasound, submandibular, submental

Introduction

Age-related changes of the midface, lower face, and neck are multilayered and include dermal collagen loss, remodeling of fibrous septae, fat compartment changes, and laxity of the superficial musculoaponeurotic system (SMAS) and superficial fascia. Energy-based devices were developed to induce controlled thermal injury within targeted planes, driving neocollagenesis and tissue contraction while preserving the epidermis. Focused ultrasound can generate discrete thermal coagulation points (TCPs) at reproducible depths, including the SMAS plane, which provided an early anatomic rationale for noninvasive lifting approaches [1,2].

Clinical studies of microfocused ultrasound and high-intensity focused ultrasound (HIFU) have reported improvement in facial laxity with acceptable safety profiles, commonly measured using Global Aesthetic Improvement Scale (GAIS) ratings and standardized photography [3-5]. More recently, micro-pulsed HIFU

(MP-HIFU) platforms, using segmented/pulsed energy delivery and multiple focal depths, have been investigated to reduce discomfort and to enable multi-depth protocols spanning superficial dermis, deep dermis/subcutaneous interface, SMAS/superficial fascia, and deeper subcutaneous fat for combined lifting and contouring [6,7].

Focused ultrasound is an established treatment modality, and both multilayer treatment approaches and three-dimensional (3D) outcome assessment have been described previously [6,8,9]. The present study contributes additional clinical observations from a retrospective series of 23 patients treated using a multilayer MP-HIFU approach, with particular attention to facial laxity and lower-face, submental, and submandibular contouring. The purpose is to describe the treatment framework and the observed outcomes in this cohort. Comparative effectiveness and the contribution of individual treatment depths were outside the scope of this study.

Materials And Methods

Study design and participants

This single-center retrospective observational case series included 23 consecutive adult patients treated with multilayer MP-HIFU for facial lifting and lower-face/submental contouring. Eligibility criteria included mild-to-moderate facial laxity and/or lower-face/submental fullness and a desire for nonsurgical aesthetic improvement. Exclusion criteria included pregnancy, active infection in the treatment area, implanted electrical devices, recent ablative procedures, and conditions that could impair wound healing. Publication was not planned at the time of treatment, and the decision to retrospectively review and report the clinical outcomes was made after those outcomes had been observed. Ethics committee approval was not sought or obtained for this retrospective case series.

Device and multilayer protocol

Treatments were performed using the Ultraformer MPT system (CLASSYS Inc., Seoul, Republic of Korea), with transducers selected according to the anatomical region and treatment objectives. Both Normal and micro-pulsed (MP) operating modes were used. Energy settings were individualized according to patient characteristics, tissue thickness, anatomical region, and treatment tolerance. The 1.5-mm transducer was used in MP mode, whereas the 2.0-mm transducer was used in Normal mode. The 3.0- and 4.5-mm transducers were used in either Normal or MP mode, with energy settings varying according to the treatment region. The 6.0-mm transducer was used exclusively in MP mode in the submental region. Table *1* summarizes the working energy-setting ranges reported retrospectively by the treating physician. Detailed patient-specific energy-setting records could not be retrieved for this analysis. Consequently, these ranges describe the operator-reported treatment approach rather than verified minimum and maximum values derived from individual patient records. A reliable cohort mean, or standard deviation of the energy settings, could not be calculated.

Focal depth	Intended target plane	Treatment regions	Operating mode	Operator-reported energy-setting range (J)	Illustrative line count per session*
1.5 mm	Superficial dermis	Perioral/periorbital areas, if treated; superficial cheek and skin texture areas	MP	0.1-0.2	150-250
2.0 mm	Mid-dermis/reticular dermis	Cheek and lower face	Normal	0.1-0.2	200-300
3.0 mm	Deep dermis/dermal-subcutaneous interface	Midface and jawline	Normal and MP	0.1-0.6	200-300
4.5 mm	SMAS/superficial fascia	Midface and mandibular border/jawline	Normal and MP	0.1-0.8	150-250
6.0 mm	Deeper subcutaneous fat in the submental region	Submental region only	MP	0.4-1.0	80-160

TABLE 1: Multilayer HIFU treatment framework, operating modes, and operator-reported working energy ranges.

Energy settings were individualized according to patient characteristics and treatment region. The ranges were reported retrospectively by the treating physician. Detailed patient-specific energy-setting records could not be retrieved; therefore, these values represent operator-reported working ranges rather than verified cohort minima and maxima. No cohort mean or standard deviation was calculated. The ranges for the 3.0- and 4.5-mm transducers are not stratified by operating mode or anatomical region. Values refer to nominal device energy settings in joules; total energy delivered per treatment line was not retrospectively reconstructed. *Line-count ranges illustrate the treatment framework and are not presented as verified patient-level or cohort-level treatment counts.

HIFU: high-intensity focused ultrasound; MP: micro-pulsed; SMAS: superficial musculoaponeurotic system

Figure *1* schematically illustrates the focal depths and intended anatomical target planes of the multilayer treatment approach.



FIGURE 1: Schematic multi-depth targeting used in multilayer MP-HIFU protocols for face and submentum.

MP-HIFU: micro-pulsed high-intensity focused ultrasound; SMAS: superficial musculoaponeurotic system

Outcome measures

Standardized photographs and 3D imaging (LifeViz System; Quartier Latin SAS, Biot, France) were acquired at baseline and follow-up. Aesthetic improvement was assessed using the GAIS [10]. GAIS ratings were assigned by the treating physician, who was not blinded to treatment status or follow-up time point. For the present analysis, the five response categories were coded as 1 = worse, 2 = no change, 3 = improved, 4 = much

improved, and 5 = very much improved, with higher scores indicating greater improvement. Selected 3D images provided illustrative documentation of individual clinical appearances. Adverse events were also assessed.

Statistical analysis

Analyses were descriptive. Investigator-rated GAIS outcomes were summarized as category counts and percentages at the 12- and 24-week assessments. Selected 3D images were used to illustrate individual clinical appearances. No inferential statistical tests were used to support the reported outcomes.

Results

Participants and treatment

Twenty-three patients were treated. All patients completed the Week 12 and Week 24 follow-up visits. Treatments were delivered without interruption and were well tolerated without topical anesthesia or cooling support. Participant characteristics and follow-up intervals are summarized in Table 2.

Characteristic	Value (n = 23)
Age, years, mean ± SD	39.2 ± 7.4
Sex, n (%)	
Female	21 (91.3)
Male	2 (8.7)
Fitzpatrick skin type, n	
II	2
III	12
IV	9
Primary concern, n	
Jawline laxity	23
Submental fullness	18
Submandibular fullness	15
Follow-up interval, weeks, median (IQR)	
Week 12 assessment	12 (12-13)
Week 24 assessment	24 (24-26)

TABLE 2: Baseline participant characteristics.

GAIS outcomes

Investigator-rated GAIS demonstrated improvement at both follow-up time points (Table 3 and Figure 2). At Week 12, 22/23 patients (95.7%) were rated improved or better; 15/23 (65.2%) were rated much improved or very much improved. At Week 24, 21/23 (91.3%) remained improved or better.

GAIS category	Week 12, n (%)	Week 24, n (%)
Worse (1)	0 (0.0)	0 (0.0)
No change (2)	1 (4.3)	2 (8.7)
Improved (3)	7 (30.4)	9 (39.1)
Much improved (4)	11 (47.8)	9 (39.1)
Very much improved (5)	4 (17.4)	3 (13.0)
Total	23 (100)	23 (100)

TABLE 3: Investigator Global Aesthetic Improvement Scale (GAIS) distribution.

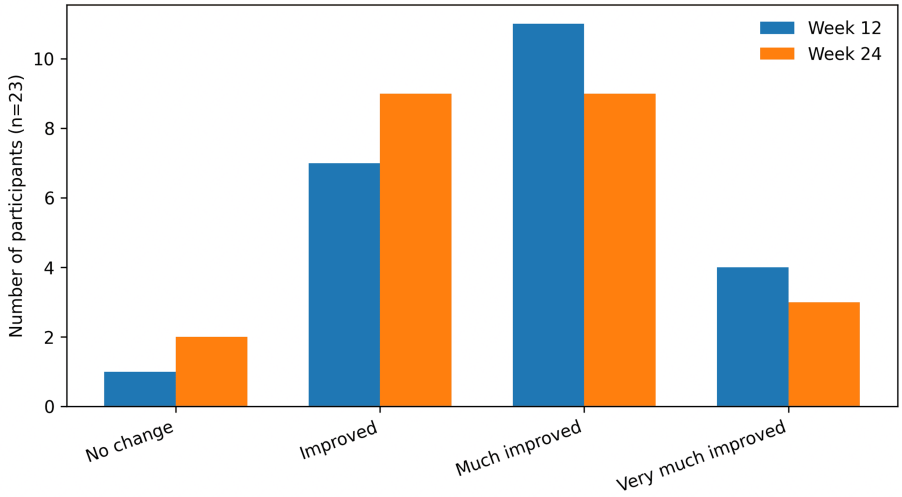


FIGURE 2: Investigator GAIS distribution at Week 12 and Week 24 after multilayer MP-HIFU (n=23).

GAIS: Global Aesthetic Improvement Scale; MP-HIFU: micro-pulsed high-intensity focused ultrasound

3D volumetric outcomes

3D surface and volumetric mapping using the LifeViz System demonstrated reductions in lower-face and submental volume consistent with improved jawline definition and cervicomental contour. Representative cases are shown in Figures *3*-*5*.

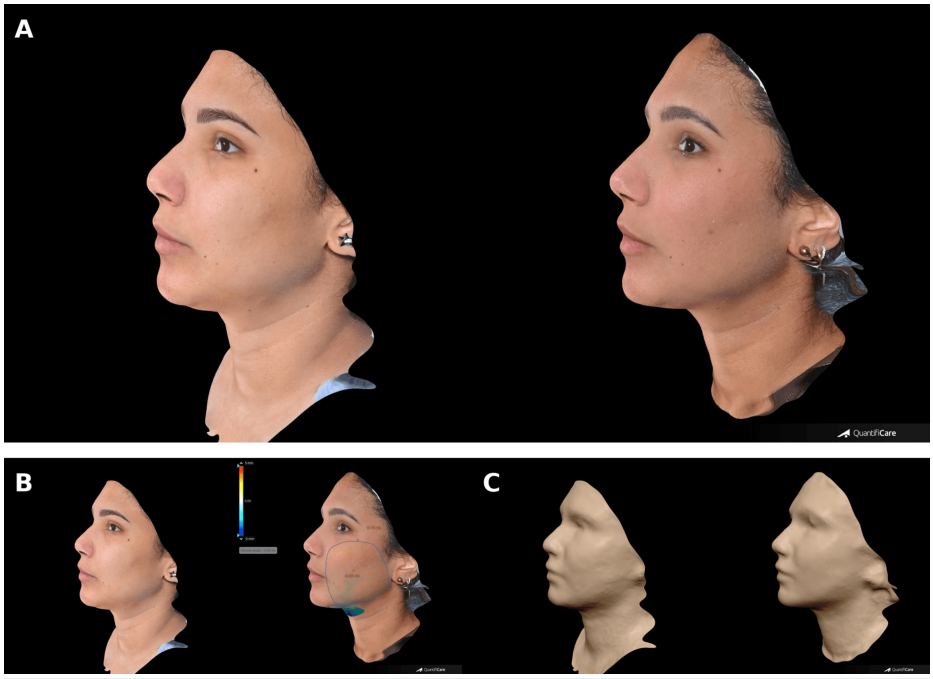


FIGURE 3: Representative case 1 (24-week follow-up).

(A) Baseline and follow-up 3D photographic renderings. (B) Volumetric map demonstrating localized volume reduction. (C) Surface-only 3D rendering.

Written informed consent was obtained from the patient for publication of this article and the accompanying images.

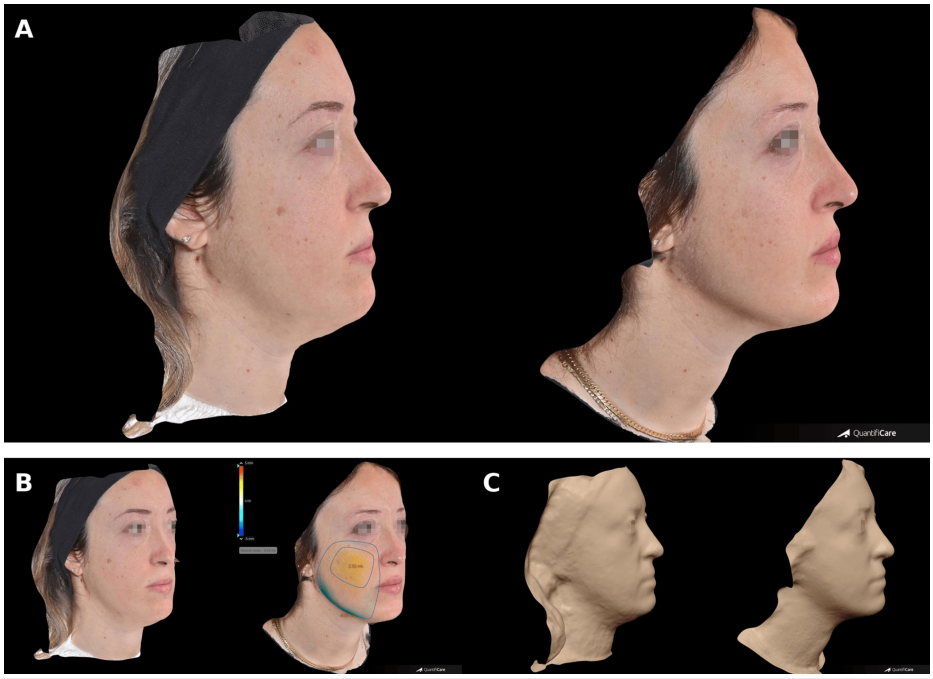


FIGURE 4: Representative case 2 (24-week follow-up).

(A) Baseline and follow-up 3D photographic renderings. (B) Volumetric map. (C) Surface-only 3D rendering.

Written informed consent was obtained from the patient for publication of this article and the accompanying images.

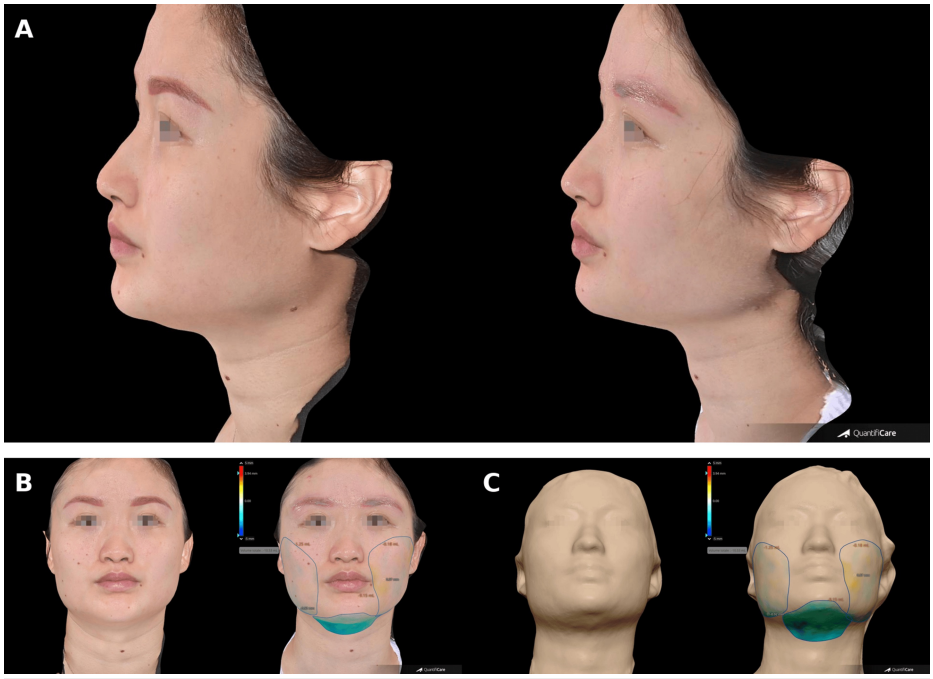


FIGURE 5: Representative case 3 (24-week follow-up).

(A) Lateral profile baseline and follow-up showing submental contour improvement. (B) Frontal view with volumetric mapping overlay. (C) Surface-only 3D rendering with volumetric map.

Written informed consent was obtained from the patient for publication of this article and the accompanying images.

Safety

Transient erythema, edema, and localized tenderness were common and resolved spontaneously within several days. No cases of neuropraxia, skin burns, or clinically evident salivary gland injury were observed in this series.

Discussion

In this 23-patient clinical series, multilayer MP-HIFU was associated with clinically apparent lifting and contouring improvements across the midface, jawline, and submental/submandibular regions. The observed improvements in investigator-rated GAIS scores and objective 3D volumetric mapping are consistent with findings from previous clinical studies of microfocused ultrasound/HIFU, which have reported tightening and lifting effects assessed using GAIS and standardized photography [3]. The mechanistic rationale for multi-depth treatment is supported by foundational work demonstrating that focused ultrasound can create discrete TCPs within the SMAS and deeper connective tissue without epidermal disruption, providing a noninvasive pathway to tissue contraction and remodeling [1,2].

Histologic and histometric studies further support collagen remodeling after focused ultrasound exposure and show that different energy modalities and parameters can produce different tissue responses [11-13]. MP-HIFU platforms extend this paradigm by segmenting energy delivery and enabling multi-depth treatment in a single session; emerging studies suggest that frequency and depth selection may influence the balance between tightening, contouring, and tolerability [6,7]. Clinically, combining superficial dermal targets (1.5-3.0 mm) with deeper SMAS/superficial fascia targets (4.5 mm) and, when appropriate, deeper subcutaneous fat targets (6.0 mm in the submentum/submandibular region) may allow simultaneous improvements in surface laxity, structural support, and lower-face fullness [6,8,14]. The submental and submandibular regions are high-impact aesthetic units that contribute disproportionately to perceived age and facial contour, yet they are anatomically heterogeneous with variable fat thickness and proximity to neurovascular and salivary gland structures. Published work on focused ultrasound for submental fat reduction supports that deeper focal depths can reduce submental adiposity and improve contour in appropriately selected patients [8]. This series also underscores the value of standardized 3D imaging for documenting treatment effects beyond traditional photography. Objective quantification has been used to detect measurable changes across multiple facial aesthetic units after focused ultrasound and may improve reproducibility and patient counseling [6,9].

This study is limited by its retrospective, single-center design, small sample size, and absence of a control

group. The decision to report the series after the outcomes had been observed introduces the potential for selection and reporting bias. Investigator-rated aesthetic outcomes may be influenced by observer expectations and image-acquisition conditions. Individualized treatment parameters limit reproducibility and prevent attribution of the observed changes to a specific focal depth or treatment component. Longitudinal measurements of body weight were not available; therefore, the potential contribution of weight changes to the observed facial and submental contour changes could not be evaluated. The three illustrated cases cannot establish the distribution of responses across the cohort. Furthermore, changes in surface appearance or contour do not directly demonstrate the underlying histological mechanism. Finally, the absence of serious adverse events in this small series cannot exclude uncommon complications. Larger controlled studies with standardized outcome assessment, longitudinal monitoring of body weight, and complete quantitative reporting are required. Meta-analytic evidence supports overall effectiveness and a generally favorable safety profile for MFU-V/HIFU, but heterogeneity in protocols and endpoints remains a challenge [15].

Conclusions

In this retrospective series of 23 patients, investigator-rated aesthetic improvement was observed following a single session of multilayer MP-HIFU. The findings provide preliminary descriptive evidence supporting further evaluation of this approach for facial and submental/submandibular contouring. The uncontrolled design does not establish comparative effectiveness or identify the contribution of individual treatment depths. Larger controlled studies incorporating standardized imaging, independent outcome assessment, and complete quantitative reporting are warranted.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Massimo Vitale, Kyuho Yi, Konstantin Frank

Acquisition, analysis, or interpretation of data: Massimo Vitale, Kyuho Yi

Drafting of the manuscript: Massimo Vitale, Kyuho Yi, Konstantin Frank

Critical review of the manuscript for important intellectual content: Massimo Vitale, Kyuho Yi

Supervision: Massimo Vitale, Kyuho Yi

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. White WM, Makin IR, Barthe PG, Slayton MH, Gliklich RE: Selective creation of thermal injury zones in the superficial musculoaponeurotic system using intense ultrasound therapy: a new target for noninvasive facial rejuvenation. Arch Facial Plast Surg. 2007, 9:22-9. 10.1001/archfaci.9.1.22
2. Alam M, White LE, Martin N, Witherspoon J, Yoo S, West DP: Ultrasound tightening of facial and neck skin: a rater-blinded prospective cohort study. J Am Acad Dermatol. 2010, 62:262-9. 10.1016/j.jaad.2009.06.039
3. Park H, Kim E, Kim J, Ro Y, Ko J: High-intensity focused ultrasound for the treatment of wrinkles and skin laxity in seven different facial areas. Ann Dermatol. 2015, 27:688-93. 10.5021/ad.2015.27.6.688
4. Shome D, Vadera S, Ram MS, Khare S, Kapoor R: Use of micro-focused ultrasound for skin tightening of mid and lower face. Plast Reconstr Surg Glob Open. 2019, 7:e2498. 10.1097/GOX.0000000000002498
5. Werschler WP, Werschler PS: Long-term efficacy of micro-focused ultrasound with visualization for lifting and tightening lax facial and neck skin using a customizedvectoring treatment method. J Clin Aesthet Dermatol. 2016, 9:27-33.
6. Kim JS: Three-dimensional analysis of lifting effects after high-intensity focused ultrasound (Ultraformer-MPT) across seven facial aesthetic units considering sonoanatomy. Plast Reconstr Surg Glob Open. 2024, 12:e6203. 10.1097/GOX.0000000000006203
7. Hwang Y, Wan J, Yi KH: Do different high-intensity-focused ultrasound frequencies have different effects? A

histological analysis correlated with patients' subjective assessments. J Cosmet Dermatol. 2025, 24:e70069. 10.1111/jocd.70069

8. Lio ML, Chang CC, Chuang AD, Tsai LC, Chen CC: Quantified facial rejuvenation utilizing high intense focus ultrasound with multiple penetrative depths. Clin Cosmet Investig Dermatol. 2022, 15:489-96. 10.2147/CCID.S350556
9. Narins RS, Brandt F, Leyden J, Lorenc ZP, Rubin M, Smith S: A randomized, double-blind, multicenter comparison of the efficacy and tolerability of Restylane versus Zyplast for the correction of nasolabial folds. Dermatol Surg. 2003, 29:588-95. 10.1046/j.1524-4725.2003.29150.x
10. Fabi SG: Noninvasive skin tightening: focus on new ultrasound techniques . Clin Cosmet Investig Dermatol. 2015, 8:47-52. 10.2147/CCID.S69118
11. Suh DH, So BJ, Lee SJ, Song KY, Ryu HJ: Intense focused ultrasound for facial tightening: histologic changes in 11 Patients. J Cosmet Laser Ther. 2015, 17:200-3. 10.3109/14764172.2015.1007065
12. Suh DH, Choi JH, Lee SJ, Jeong KH, Song KY, Shin MK: Comparative histometric analysis of the effects of high-intensity focused ultrasound and radiofrequency on skin. J Cosmet Laser Ther. 2015, 17:230-6. 10.3109/14764172.2015.1022189
13. Baumann L, Zelickson B: Evaluation of micro-focused ultrasound for lifting and tightening neck laxity . J Drugs Dermatol. 2016, 15:607-14.
14. Pavicic T, Ballard JR, Bykovskaya T, et al.: Microfocused ultrasound with visualization: consensus on safety and review of energy-based devices. J Cosmet Dermatol. 2022, 21:636-47. 10.1111/jocd.14666
15. Amiri M, Ajasllari G, Llane A, et al.: Microfocused ultrasound with visualization (MFU-V) effectiveness and safety: a systematic review and meta-analysis. Aesthet Surg J. 2025, 45:NP86-94. 10.1093/asj/sjae228