Review

Microfocused Ultrasound in Aesthetic Medicine: An Update and Critical Review

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Abstract: ***Background:*** The demand for noninvasive aesthetic procedures has surged, positioning microfocused ultrasound and high-intensity focused ultrasound as foundational modalities for tissue lifting and tightening. While early literature established its basic efficacy, the rapid evolution of clinical protocols, novel combinations, and expanded anatomical indications necessitates a re-evaluation of the evidence. ***Methods:*** A systematic critical review was conducted to evaluate recent literature between year 2024 and year 2026 within MEDLINE, PubMed, and Ovid databases.. Data extraction focused on study design, primary clinical outcomes, safety profiles, and methodological limitations. Evidence was synthesized chronologically and thematically, with all included studies were rigorously classified according to the Oxford Centre for Evidence-Based Medicine Levels of Evidence (March 2009) to appropriately stratify the current clinical landscape. ***Results:*** Fifty-seven studies met the inclusion criteria. Recent evidence robustly supports the efficacy of microfocused ultrasound for mild-to-moderate facial and cervical laxity. Emerging literature highlights successful integration with injectable biostimulators, dermal fillers, and other energy-based devices. Furthermore, expanded indications, including superficial skin quality improvements and body contouring, show promise. The safety profile remains highly favorable, characterized predominantly by transient erythema and localized edema, though rare reports of significant ocular or neurological complications underscore the importance of anatomical precision. ***Conclusions:*** Microfocused ultrasound remains a versatile and highly effective noninvasive modality in aesthetic medicine. While optimal outcomes are consistently observed in lower face and neck lifting, future research must prioritize standardized protocols for novel body indications, long-term follow-up for combination therapies, and rigorous anatomical guidelines to mitigate rare adverse events.

Keywords: ultrasonic therapy; cosmetic techniques; skin aging; rejuvenation; face; dermal fillers

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1. Introduction

The landscape of aesthetic medicine has undergone a paradigm shift over the past decade, driven by an escalating patient preference for noninvasive and minimally invasive rejuvenation procedures [1]. As individuals increasingly seek interventions that offer noticeable aesthetic improvements without the extensive downtime and surgical risks associated with traditional rhytidectomy, energy-based devices have become a cornerstone of dermatological and plastic surgery practices [2]. Among these technologies, microfocused ultrasound (MFU), often utilized with high-resolution visualization (MFU-V), and high-intensity focused ultrasound (HIFU) have distinguished themselves as uniquely capable modalities for deep tissue lifting, collagen stimulation, and comprehensive facial contouring [3]. Unlike lasers, which rely on the photothermolysis of specific chromophores and are fundamentally limited by optical scattering and epidermal absorption [4], ultrasound energy bypasses the skin surface entirely [5]. It propagates through the epidermis and dermis to converge at precise focal points within the subcutaneous tissue and the superficial musculoaponeurotic system (SMAS) [6]. At these focal zones, the acoustic energy generates rapid, localized thermal coagulation points, typically reaching temperatures between 60 °C and 70 °C, which triggers immediate collagen fiber contraction and initiates a robust, long-term neocollagenesis cascade [7].

The precise targeting capabilities of MFU and HIFU render them particularly attractive in modern aesthetic practices, differentiating them from radiofrequency (RF) devices that generally produce a broader, more diffuse bulk heating effect [8]. While bulk heating is effective for superficial tissue tightening, the ability of focused ultrasound to reliably reach depths of up to 4.5 mm allows practitioners to structurally manipulate the SMAS layer, the exact anatomical plane targeted during surgical facelifts [9]. Consequently, MFU has become a primary nonsurgical alternative for addressing mild-to-moderate facial and cervical laxity [10]. However, the period between 2024 and 2026 has witnessed a remarkable expansion in the clinical application and conceptual understanding of focused ultrasound. The technology is no longer viewed merely as a standalone lifting tool; instead, it is increasingly positioned within a highly integrated, multimodal regenerative approach. The recent literature reflects a surge in studies exploring synergistic combinations, such as coupling MFU-V with hyperdilute calcium hydroxylapatite or poly-L-lactic acid to amplify the biostimulatory response [11]. Furthermore, an evolving appreciation for superficial ultrasound depths (e.g., 1.5 mm) has expanded the indications of MFU to encompass generalized skin quality enhancements, including the improvement of surface evenness, tone, and fine rhytids [12].

Alongside these expanding clinical frontiers, the geographic and demographic scope of ultrasound research has diversified. A growing body of literature is dedicated to optimizing treatment parameters for skin of color, as ultrasound energy does not interact with epidermal melanin, making it inherently safer for higher Fitzpatrick skin types compared to many optical devices [13]. Despite this widespread enthusiasm and clinical success, the integration of focused ultrasound into diverse and complex protocols introduces new critical considerations regarding safety and standardization [14]. While the overarching safety profile is recognized as favorable, which is dominated by transient and self-resolving erythema, mild edema, and procedure-related discomfort [15]. Recent clinical reports have highlighted that rare but severe complications, such as motor nerve paresis and severe ocular injuries, can occur when anatomical boundaries are breached or practitioner training is insufficient [16].

This rapid proliferation of new protocols, extended indications, and combinatorial strategies over the past three years creates an urgent need for a critical synthesis of the literature. Existing reviews often focus narrowly on isolated aspects of focused ultrasound or fail to encompass the latest high-level evidence generated since 2024. A rigorous, updated evaluation is essential to separate highly validated protocols from those based merely on anecdotal or preliminary findings. While systematic reviews have confirmed the overarching efficacy of MFU for sagging skin [3], the heterogeneity of clinical end-points, device specifications, and follow-up durations complicates clinical decision-making. Moreover, the literature mapping body contouring indications remains disjointed, requiring careful appraisal to guide best practices [17]. To address these gaps and provide a definitive resource for practitioners, this article critically reviews the evidence base concerning focused ultrasound in aesthetic medicine. By systematically evaluating the literature from 2024 to 2026, this review aims to clarify optimal treatment paradigms, assess the veracity of combination therapies, explore novel superficial and body indications, and define the modern safety profile of ultrasound-based rejuvenation. Ultimately, this comprehensive update will empower clinicians to maximize patient outcomes while navigating the evolving complexities of energy-based regenerative aesthetics.

2. Methods

A systematic critical review was conducted to evaluate recent literature between year 2024 and year 2026 within MEDLINE, PubMed, and Ovid databases. Data extraction focused on study design, primary clinical outcomes, safety profiles, and methodological limitations. Because the field of aesthetic medicine contains highly heterogeneous evidence, a broad spectrum of publication types was critically appraised. Narrative reviews, systematic reviews, clinical trials, observational studies, case reports, expert consensus statements, preclinical studies, and authoritative book chapters were all included to provide a comprehensive, multi-dimensional perspective on current clinical practices. All included studies were systematically classified using the Oxford Centre for Evidence-Based Medicine Levels of Evidence (March 2009) to standardize the assessment of methodological quality and clinical reliability [18].

3. Results

Sun et al. [19] performed a comprehensive review and bibliometric overview of focused ultrasound technology in aesthetics, tracing its evolution and forecasting future trends. The study demonstrated that while the technology enjoys a highly favorable safety profile and excellent clinical efficacy for tissue tightening, the research remains geographically concentrated, primarily in North America and East Asia. This matters to dermatologists as the geographical bias may limit the generalizability of optimal treatment protocols across diverse global populations and regulatory environments. The limitation is the reliance on retrospective publication data, which may lag behind real-time clinical innovations (Level 5).

Preman et al. [20] conducted a narrative review detailing the clinical applications of microfocused ultrasound with visualization (MFU-V) in dermatology. The article systematically evaluated mechanisms, clinical indications, contraindications, biological responses, and long-term efficacy. The authors concluded that MFU-V provides safe and reliable nonsurgical lifting. Clinically, this is vital for establishing standardized operational protocols; however, the study highlighted significant procedure-related pain and discomfort as a primary barrier to patient adherence. The limitation is the lack of a quantitative meta-analysis to definitively measure the magnitude of long-term patient satisfaction against discomfort levels (Level 5).

Li et al. [21] conducted a prospective clinical study involving 28 women to evaluate the long-term effects of micro-focused ultrasound on facial tightening using objective quantitative instruments. Following a 12-month follow-up, the study demonstrated durable facial volumetric reduction and sustained skin tightening, accompanied by only mild, transient erythema and edema. This objective validation is clinically highly significant, proving that MFU induces sustained structural remodeling rather than mere transient edema. The primary limitation is the relatively small sample size lacking a randomized control group, requiring caution when generalizing the magnitude of volumetric changes (Level 4).

Lou et al. [22] investigated the efficacy and safety of micro-focused ultrasound for middle and lower face rejuvenation in a prospective single-arm study comprising 20 Chinese women. The study reported exceptionally high clinical improvement rates at the 3- and 6-month marks, with transient muscle pain being the most notable, yet tolerable, side effect and no major complications occurring. This is clinically significant as it confirms the safety and high response rate in Asian skin phenotypes. However, the study should be interpreted with caution due to the absence of a control arm and the limited participant cohort (Level 4).

Rebelo-Marques et al. [23] presented a hybrid review analyzing lasers and ultrasound in aesthetic medicine, focusing on efficacy, safety, and future directions. The review underscored the importance of adapting protocols for skin of color, achieving high personalization, and the emerging role of AI-guided treatment planning in optimizing energy delivery. This matters to practitioners aiming to modernize their practice with algorithmic precision and safe multi-ethnic treatments. The limitation is that the hybrid methodology blends expert opinion with systematic data, potentially introducing subjective bias into the synthesis of future technical trajectories (Level 5).

Nam et al. [24] executed a retrospective comparative study evaluating a microwave energy-based device (MEBD) versus high-intensity focused ultrasound (HIFU) for facial rejuvenation in 171 East Asian patients. The results showed that while the microwave device offered better early tolerability and rapid subjective improvement, HIFU provided significantly better sustained lifting and elasticity at the 3-month mark. This informs clinical decision-making by allowing practitioners to tailor device selection based on whether patients prioritize immediate comfort or long-term structural durability. The limitation is the retrospective design, which is subject to inherent selection and follow-up biases (Level 2b).

Qi et al. [25] reported on a preclinical porcine ex vivo mechanistic study assessing thermal accumulation and collagen remodeling induced by micro-focused ultrasound. The researchers demonstrated parameter-dependent efficacy, showing that precise focal-depth thermal accumulation directly correlates with robust collagen denaturation and remodeling. This is crucial for aesthetic clinicians as it biologically validates the dose-response relationship of specific transducer depths and energy settings used in human facial tightening. The limitation is that ex vivo models lack active vascular perfusion, which naturally dissipates heat, meaning clinical thermal thresholds may differ slightly (Level 5).

Kono et al. [26] provided a detailed review and analysis of adverse events associated with aesthetic high-intensity focused ultrasound treatment. The authors mapped the mechanisms of injury, demonstrating that while overall safety is high, severe adverse events like burns or nerve paresis occur due to improper transducer coupling or anatomically incorrect depth targeting. This is of paramount clinical importance for risk management and anatomical training. The limitation is the reliance on voluntary adverse event reporting and published case series, which likely underestimates the true incidence of minor, unreported complications (Level 5).

Kumar et al. [27] published a bibliometric-systematic overview focusing on high-intensity focused ultrasound for body rejuvenation and contouring. The study showed a growing but still notably limited literature base dedicated to body indications, heavily dominated by research from the United States and South Korea. This is clinically relevant as it highlights an expanding frontier for noninvasive fat reduction and tissue tightening beyond the face. However, caution is warranted because the relative scarcity of diverse global data limits the establishment of universally standardized body contouring parameters (Level 5).

Jin et al. [28] evaluated the optimal sequence of combining poly-L-lactic acid (PLLA) injections with micro-focused ultrasound in a miniature pig preclinical study. The authors found that applying MFU immediately prior to PLLA injection significantly enhanced dermal remodeling and collagen production without destabilizing or prematurely degrading the PLLA microspheres. This is highly significant for aesthetic providers seeking to maximize synergistic biostimulation safely in a single session. The limitation is that it is an animal model, and human fibrotic or inflammatory responses to immediate sequential therapy may vary (Level 5).

Faria et al. [29] contributed a narrative review demystifying pain during microfocused ultrasound by analyzing facial layer sensitivity. The authors proposed that procedural pain intensity is closely linked to anatomical innervation and might actually correlate with highly accurate targeting of the SMAS and subdermal layers. This matters to dermatologists as it re-frames procedural discomfort from a mere adverse effect to a potential real-time bio-feedback mechanism for effective depth targeting. The limitation is the speculative nature of this correlation, which lacks large-scale quantitative human trials to definitively prove efficacy-pain proportionality (Level 5).

Bastedo et al. [30] presented an evidence review on the optimization of facial aesthetic outcomes through the multimodal sequencing of energy devices and injectables. The article outlined a "Layering Energies" framework, suggesting that sequencing ultrasound, radiofrequency, and biostimulators targeting distinct anatomical planes yields superior structural support. This is clinically vital for shifting practices from monotherapy to comprehensive three-dimensional facial restoration. The limitation is that standardized, controlled clinical data validating specific layering intervals remain scarce, relying heavily on expert consensus and theoretical synergy (Level 5).

Zappia et al. [31] conducted a retrospective evaluation of a dual-modality approach utilizing a 675 nm laser and microfocused ultrasound in 115 patients with facial aging. The study demonstrated that the combined therapy was significantly superior to either modality alone at the 6-month follow-up, achieving enhanced tightening without any major adverse events. This provides robust clinical support for combining non-ablative superficial lasers with deep ultrasound to address multi-layered aging. The limitation is the retrospective cohort design, which lacks the rigor and blinding of a prospective randomized trial (Level 2b).

Piccolo et al. [32] authored a book chapter exploring the integration of energy-based devices with autologous regenerative therapies. The authors detailed how combining microfocused ultrasound with autologous fat grafting or platelet-rich plasma can create a powerful synergy, enhancing graft survival and tissue tightening simultaneously. This is highly relevant for advanced aesthetic surgeons seeking to merge biological regeneration with biophysical energy. The limitation is that the evidence is primarily presented as expert protocols and theoretical constructs rather than high-powered comparative clinical trials (Level 5).

Nazari et al. [33] published a comprehensive book chapter detailing the use of high-intensity focused ultrasound in office-based facial cosmetic surgery. The text systematically outlines clinical indications, operational techniques, strict contraindications, and safety protocols for integrating HIFU into surgical practices. This serves as a vital educational tool for surgeons transitioning toward noninvasive or hybrid treatment paradigms. The limitation is the didactic nature of the chapter, which inherently relies on the authors' clinical experience rather than generating new empirical data (Level 5).

Jurcevic et al. [34] provided a narrative multimodal review on facial rejuvenation, explicitly placing focused ultrasound within a layered aesthetic approach. The authors argued that optimal patient outcomes require the integration of hyaluronic acid fillers, collagen stimulators, botulinum toxin, and energy-based devices, sequenced from deep structural support to superficial skin quality. This matters to clinicians by providing a holistic roadmap for pan-facial rejuvenation. The limitation is that it does not provide strict quantitative guidelines on the ideal temporal spacing between these disparate modalities (Level 5).

Song et al. [35] performed a retrospective evaluation of 30 Asian women to assess the clinical efficacy and safety of shallow-dermal linear HIFU for fine-wrinkle reduction. The findings revealed that shallow-dermal HIFU significantly improved wrinkle depth, skin roughness, and elasticity, with only mild, transient erythema and edema reported. This is clinically significant as it validates the use of superficial focal depths (e.g., 1.5 mm) for addressing epidermal/dermal skin quality issues rather than just deep lifting. The limitation is the small sample size and lack of a non-treated control group (Level 4).

Vachiramon et al. [36] conducted a narrative review focusing on microfocused ultrasound with visualization in regenerative aesthetics. The review synthesized the mechanism of action and clinical outcomes, concluding that MFU-V effectively drives deep neocollagenesis and elastin remodeling, positioning it as a core regenerative rather than merely a tightening device. This conceptual shift is significant for practitioners explaining long-term tissue health benefits to patients. The limitation is the narrative format, which lacks the statistical rigor required to quantify the exact magnitude of regenerative tissue changes across populations (Level 5).

Amiri et al. [37] performed a robust systematic review and meta-analysis of the effectiveness and safety of MFU-V. The statistical synthesis confirmed high patient satisfaction, substantial improvements in objective skin quality, and a highly favorable safety profile across numerous clinical trials. This is of critical importance as it provides high-level mathematical confirmation of MFU-V's reliability as a gold-standard lifting device. The limitation noted by the authors is the moderate-to-high heterogeneity among the included studies regarding objective measurement scales and long-term follow-up intervals (Level 1a).

Amiri et al. [38] completed a systematic review of human evidence on the aesthetic efficacy and safety of combining MFU-V with calcium hydroxylapatite (CaHA). The study concluded that this specific combination is highly synergistic, safe, and superior to monotherapy for enhancing jawline contour and dermal thickness. This matters to clinicians as it strongly validates one of the most popular off-label combination protocols in modern aesthetics. However, caution is warranted as the total number of high-quality comparative studies in the literature remains relatively small (Level 1a).

Pavicic et al. [39] authored a narrative review specifically evaluating the impact of MFU-V on superficial skin quality. The authors found that beyond deep lifting, MFU-V significantly improves parameters such as surface firmness, evenness, skin tone, and overall glow. This is clinically valuable because it expands the marketed indications of the device to patients primarily concerned with texture rather than severe laxity. The limitation is the reliance on subjective investigator and patient-reported outcome measures, which are susceptible to significant observer bias (Level 5).

Park et al. [40] presented a practical review and experience paper detailing the customization of MFU-V treatments for facial lifting in Asian men. The authors developed anatomy-guided protocols that accommodate thicker dermal tissue, heavier lower facial fat, and the specific aesthetic desires for strong jawline definition in this demographic. This is highly significant for advancing gender- and ethnicity-specific aesthetic algorithms. The limitation is that the recommendations are heavily based on regional Korean clinical experience, which may not uniformly apply to broader international male cohorts (Level 5).

Biskanaki et al. [41] conducted a comprehensive review on the complications and risks associated with HIFU in esthetic procedures. The authors emphasized that while the vast majority of complications are mild and transient (erythema, swelling), the risk of severe thermal burns or nerve injury remains present, necessitating rigorous practitioner vigilance. This is vital for maintaining high safety standards and proper informed consent in clinical practice. The limitation is the lack of a standardized reporting denominator, making it difficult to calculate the exact global incidence rate of severe complications (Level 5).

Wang et al. [42] executed a prospective, randomized, split-face study investigating the combination of novel microfocused ultrasound with a microneedle fractional radiofrequency (MFR) system. The study definitively showed that combining MFU with MFR was superior to a single modality for comprehensive multilayered rejuvenation, dramatically improving tightening, pigmentation, and pore size. This is clinically significant as it provides high-level evidence for same-day, multi-device layering targeting the SMAS and superficial dermis simultaneously. The limitation is the potential for increased localized downtime and the complexity of distinguishing specific adverse events (Level 1b).

Doyle et al. [43] reported a pilot comparative sequence study in 12 women targeting the lower face and submentum with MFU-V and hyperdilute CaHA. The authors demonstrated that administering MFU-V first, followed by delayed hyperdilute CaHA, yielded superior lifting and skin laxity reduction compared to alternative sequences. This helps clinicians optimize scheduling to maximize biostimulatory yield while minimizing compounding inflammation. The limitation is the very small pilot sample size, meaning these sequence findings require validation in much larger, randomized multicenter trials (Level 2b).

Modena et al. [44] published a systematic review and meta-analysis assessing microfocused ultrasound treatment for sagging skin. The meta-analysis mathematically supported significant improvements in facial sagging but highlighted substantial study heterogeneity in treatment energy levels and clinical scoring systems. This matters as it provides unimpeachable evidence of efficacy while simultaneously calling for urgent standardization in clinical research methodologies. The limitation is that the pooled effect sizes might be skewed by the high heterogeneity of the underlying primary studies (Level 1a).

Suh et al. [45] presented an 18-year comprehensive retrospective safety study involving 1040 patients treated with microfocused ultrasound, monopolar radiofrequency, and cosmetic injectables. The massive dataset revealed an exceptionally low serious event burden, confirming the long-term safety of stacking these specific modalities over years of aesthetic maintenance. This is highly reassuring for practitioners managing lifelong aesthetic patients. The limitation is the retrospective nature of the chart reviews, which likely resulted in the underreporting of minor, transient adverse events that patients did not seek clinical care for (Level 2c).

Heitzmann et al. [46] contributed an early clinical case-series style report on first clinical experiences with microfocused ultrasound in infraorbital rejuvenation. The authors reported visible improvements in under-eye laxity and fine lines, proposing MFU as a scientifically grounded, non-invasive alternative to blepharoplasty for early aging. This is clinically significant given the anatomical difficulty of safely treating the delicate periocular region. However, this must be interpreted with caution due to the case-series design and the extremely thin dermal tissue over the orbital rim, which increases complication risks (Level 4).

Choi et al. [47] conducted a controlled clinical study comparing protocols for temporary eyebrow lift and glabellar wrinkle reduction using microfocused ultrasound. The findings showed that a deeper, multi-depth protocol appeared stronger and more durable for eyebrow elevation while maintaining a good safety profile. This helps clinicians tailor upper-face treatments by selecting appropriate transducer depths to achieve mechanical lifting without neurovascular injury. The limitation is the relatively short follow-up period, leaving the precise duration of the temporary eyebrow elevation unconfirmed (Level 1b).

Humphrey et al. [48] performed a systematic review to evaluate adverse events associated with MFU-V and its potential risk of compromising subsequent facelift surgeries. The authors found very little evidence of meaningful facelift compromise, dispelling surgical myths that MFU causes prohibitive deep tissue scarring. This is clinically vital for reassuring patients who use MFU as a bridge therapy before eventual surgical rhytidectomy. The limitation is the reliance on retrospective surgical observations rather than prospective histological tracking of SMAS tissue post-ultrasound (Level 1a).

Lin et al. [49] published a global expert consensus on best practices for MFU-V treatment of body indications, specifically focusing on the abdomen and arms. The consensus provided detailed anatomical guidelines, patient selection criteria, and energy parameters to ensure safe, effective skin tightening off the face. This provides a much-needed standardized framework for the rapidly expanding field of noninvasive body contouring. The limitation is that it represents level 5 expert consensus, which, while highly authoritative, still requires validation through large-scale prospective clinical trials (Level 5).

Harnchoowong et al. [50] investigated the effect of micro-focused ultrasound treatment on intradermal Botulinum toxin type A in a controlled study. The results demonstrated that performing superficial MFU too soon after an intradermal botulinum toxin injection significantly reduced the clinical efficacy and longevity of the neuromodulator. This matters tremendously to dermatologists planning same-day combination therapies, dictating that ultrasound should precede toxin administration. The limitation is that the exact temporal threshold for safety (e.g., waiting 2 versus 4 weeks) remains imprecisely defined (Level 2b).

Dicker et al. [51] authored a comparative literature review of device specifications among various high-intensity focused ultrasound platforms used for skin tightening. The review highlighted substantial technical heterogeneity between platforms concerning energy delivery, focal volume, and ultrasound frequency. This is clinically significant as it warns practitioners that treatment protocols and safety data cannot be uniformly generalized across different commercial devices. The limitation is that the review is largely technical and descriptive, lacking direct head-to-head clinical efficacy comparisons of the devices (Level 5).

Liu et al. [52] reported a severe ocular complication case involving a patient who developed corneal leukoma with iridocyclitis following micro-focused ultrasound treatment of the periocular skin. This case report is of paramount clinical importance as it starkly illustrates the profound risks of applying deep focal ultrasound energy too close to the unprotected ocular globe. While highly rare, this limitation underscores that MFU requires absolute anatomical precision, rigorous adherence to safety boundaries over the orbital rim, and proper ocular protection during upper face treatments (Level 4).

Barton et al. [53] provided an updated book chapter in the “Manual of Cosmetic Medicine and Surgery” detailing current cosmetic uses and safety considerations of microfocused ultrasound. The text serves as an authoritative procedural guide, emphasizing proper patient selection, expected outcomes, and the critical role of visualization in avoiding vascular and neural structures. This matters as an educational baseline for aesthetic residents and fellows. The limitation is that, as a textbook chapter, it synthesizes existing broad knowledge rather than presenting novel experimental findings (Level 5).

Pavicic et al. [54] wrote a perspective article examining the expansion of MFU-V indications for arm and abdomen skin quality beyond traditional facial applications. The authors highlighted that MFU-V effectively addresses localized body crepiness and mild laxity, satisfying a growing patient demand for holistic body rejuvenation. This is clinically relevant for practices looking to expand their noninvasive body portfolio. The limitation is the perspective nature of the article, which relies heavily on anecdotal success and select clinical experiences rather than robust, controlled body-contouring data (Level 5).

Haykal et al. [55] executed a systematic review of high-intensity focused ultrasound in skin tightening and body contouring. The synthesis broadly supported the safety and efficacy of HIFU across multiple body regions but strongly noted the urgent need for standardized outcome measures and longer durability data. This matters to the aesthetic community by validating body indications while holding the industry accountable for better research standards. The limitation is the high variability in follow-up times among the included trials, preventing precise calculations of long-term contouring retention (Level 1a).

Pan et al. [56] conducted a prospective study evaluating the safety and efficacy of high-intensity macro-focused ultrasound for treating solar lentigo in Chinese patients. The study showed significant improvement in this non-traditional superficial pigmentary indication, suggesting that acoustic energy may possess unique melanosome-disrupting properties. This is clinically exciting as it proposes a completely novel use for ultrasound beyond tissue tightening. However, it should be interpreted with caution as standard Q-switched or picosecond lasers remain the established gold standard, and comparative efficacy is unknown (Level 4).

Doyle et al. [57] performed an exploratory, post hoc analysis of age-related trends in the biostimulatory response to combined CaHA and MFU-V treatments. The analysis suggested that within typical aesthetic age ranges, patient age did not strongly alter or diminish the histological collagen-producing response to the combined therapy. This is highly encouraging for older patients seeking noninvasive rejuvenation, proving that cellular senescence does not outright block treatment efficacy. The limitation is the exploratory, post hoc nature of the data, which was not originally powered to detect subtle age-related stratifications (Level 2c).

Thadanukulwattana et al. [58] conducted a prospective, randomized, double-blinded, intraindividual split-face study comparing 1.5-mm microfocused ultrasound with 2.0-mm macrofocused ultrasound for crow’s feet, infraorbital laxity, and infraorbital rhytids in 12 participants. Both modalities improved elasticity and wrinkle severity over 6–12 weeks, with overall changes ranging from 1% to 25%. Patient satisfaction and procedural pain were broadly similar between sides, but transient erythema was more frequent after macrofocused treatment. These findings suggest that both focal depths can be effective in the periocular region, although microfocused delivery may offer a more favorable tolerability profile in delicate anatomical zones. The principal limitation is the very small sample size with short follow-up (Level 1b).

Panithaporn et al. [59] reported a case of MFU treatment in a 28-year-old man with multiple longstanding titanium facial implants involving the mandible, chin, maxilla, and zygoma. Treatment with an updated MFU platform offering improved visualization enabled more precise targeting and reduced the need to omit implant-adjacent areas. The report is clinically relevant because it suggests MFU may be more suitable than certain radiofrequency modalities in patients with metallic implants, given the absence of electrically induced heating. Nevertheless, careful image-guided treatment planning remains essential because focused acoustic energy can still affect surrounding tissues. The main limitation is that the observation is based on a single patient and cannot establish generalized safety (Level 4).

Welc et al. [60] provided a narrative review of HIFU applications in aesthetic medicine, focusing on facial and neck rejuvenation, décolletage tightening, and body fat reduction. The authors described the biological rationale of ultrasound-induced thermal injury, including neocollagenesis, tissue remodeling, and adipocyte reduction, and emphasized that published outcomes are generally promising across conventional facial rejuvenation indications. The article is useful as a broad overview of how HIFU is positioned within noninvasive aesthetic practice, particularly for clinicians seeking a concise synthesis of mechanism and complication patterns. However, because the review is not a formal systematic analysis and does not provide pooled comparative estimates, its conclusions are best interpreted as contextual guidance rather than high-tier evidence (Level 5).

Weng et al. [61] performed a retrospective observational study of 58 patients who underwent combination therapy with thread lifting and HIFU for facial aging. Participants were allocated according to treatment sequence, but both groups received repeated sessions consisting of unilateral barbed thread placement and ultrasound treatment to the mid and lower face. The study showed significant improvement in physician-rated aesthetic scores and reduction in jowl fat pad distance, with no clear advantage of one sequence over the other. Clinically, the findings support the concept that structural suspension and deep-tissue energy delivery can be complementary in selected aging faces. The most important limitation is the absence of a control group, which prevents reliable comparison with either monotherapy (Level 4).

Bukhari et al. [62] conducted a retrospective cross-sectional satisfaction study among 98 women previously treated with MFU-V in private practice. Approximately two-thirds of respondents described themselves as satisfied or very satisfied, and satisfaction appeared greater for periocular and submental treatments and when procedures were performed by more senior physicians. Most adverse effects were minor and transient, mainly pain or tingling, erythema, and swelling, with no major complications reported. This study is clinically valuable because it reflects real-world patient perception rather than only investigator-assessed change. Its limitations include recall bias, the telephone survey design, and the all-female, single-center cohort, which restricts broader generalizability (Level 2c).

Chen et al. [63] evaluated upper facial rejuvenation in a rater-blinded prospective study involving 40 participants who completed 180-day follow-up. Treatment produced mean brow elevation of approximately 2.1 mm at 90 days, and 87.5% of patients were judged to have clinically meaningful brow lifting at 6 months. Three-dimensional vector analysis demonstrated upward and lateral-oblique displacement consistent with a true tightening effect rather than photographic artifact. Safety was favorable, with only transient erythema and edema and no ulceration, pigmentary change, or neuromuscular dysfunction. These findings support MFU as a noninvasive option for mild-to-moderate brow ptosis. The main limitation is the modest sample size and lack of a separate untreated comparator group (Level 2b).

Al-Jumaily et al. [64] presented a broad technical review of focused ultrasound for dermal applications, covering skin tightening, fat reduction, pigmentary indications, and even oncologic cutaneous use. The article concentrated on operational parameters that shape the ultrasound injury zone, including transducer characteristics, focal depth, and energy delivery conditions, and discussed how these influence efficacy, tolerability, and cost-efficiency. For aesthetic medicine, the review is especially relevant because it links device physics to clinically meaningful outcomes and offers a mechanistic framework for protocol selection. However, it is primarily a technical and conceptual synthesis rather than a clinical evidence hierarchy, and it does not directly resolve comparative questions between devices or treatment algorithms (Level 5).

Zhu et al. [65] conducted a prospective, randomized, controlled trial evaluating a novel MFU platform for tightening of the middle and lower face and submental region. Twenty women underwent treatment with multiple transducers, and efficacy was assessed by paired photography, three-dimensional volumetric analysis, ultrasonographic skin thickness, and photoaging parameters. Fourteen of 20 participants demonstrated clinically significant tightening during 3-month follow-up, and the treated lower face showed volumetric reduction relative to the control side. Pain scores remained modest without oral or injectable anesthesia. This study is clinically important because it combined objective imaging-based endpoints with randomized design. The chief limitation is the small cohort size and lack of individualized treatment parameter adjustment (Level 1b).

Kim et al. [66] analyzed immediate lifting effects after HIFU across seven facial aesthetic units in 50 patients using three-dimensional scanner technology and treatment planning based on sonoanatomy. The neck showed the greatest lift, followed by the posterior cheek and mandible, whereas the forehead demonstrated the smallest measurable elevation. The paper is clinically helpful because it highlights that response is not uniform across the face and that anatomical tailoring is central to optimizing outcomes. In particular, thicker and more ptotic regions appeared to derive greater measurable repositioning. The principal limitation is that the study focused on immediate posttreatment change rather than durability, so it cannot define the persistence of these lifting effects over time (Level 4).

Wang et al. [67] performed a prospective, randomized, split-face study in which patients received whole-face MFU while one randomized side also underwent delicate pulsed light treatment. By 6 months, the combination side showed greater reductions in perioral wrinkle length and nasolabial fold severity, along with better improvement in skin tone, erythema, barrier-related parameters, and elasticity than MFU alone. The study is clinically relevant because it demonstrates that combination therapy can simultaneously address laxity, dyschromia, and texture, thereby improving overall rejuvenation in multifactorial facial aging. Safety was acceptable, with no serious or permanent adverse events aside from one withdrawal for increased skin sensitivity. The main limitation is the small sample and relatively complex staged treatment schedule (Level 1b).

Wang et al. [68] investigated histological changes in Bama miniature pig skin after MFU treatment. Immediate biopsies demonstrated collagen contraction and fragmentation together with superficial capillary dilation and congestion, whereas 1-month specimens showed dermal thickening, increased collagen density, more elastin, more type I collagen, and thickened adipose septa. These tissue findings correlated with human clinical observations of transient posttreatment erythema or swelling followed by visible improvement in skin laxity. The study provides useful mechanistic support for the remodeling hypothesis that underlies MFU-based rejuvenation. Its major limitation is that animal models cannot fully reproduce the complexity of human healing, patient heterogeneity, or long-term clinical response (Level 5).

Cirilo et al. [69] described MFU use for skin laxity in a patient with classic Ehlers–Danlos syndrome, proposing a novel nonsurgical approach for a condition characterized by connective-tissue fragility. The report is clinically notable because such patients are often therapeutically challenging, and even modest improvement may be meaningful when surgical or invasive strategies are undesirable. From a review perspective, the case broadens discussion of MFU beyond routine age-related laxity and raises the question of whether carefully selected hereditary connective-tissue disorders may still benefit from controlled energy-based remodeling. The obvious limitation is that a single case cannot establish reproducible efficacy or safety in this special population (Level 4).

Silva et al. [70] explored the compatibility of PDO lifting threads with MFU in an in vitro setting. Based on the available abstracted information, the authors argued that combined use may be feasible because the melting point of PDO exceeds the temperatures typically associated with MFU treatment. This question is clinically relevant because thread-based lifting and ultrasound tightening are increasingly combined in practice, yet practitioners remain concerned about accelerated material degradation or structural compromise. The study therefore contributes preliminary bench-level reassurance but does not replace in vivo safety or performance data. Its main limitation is the restricted methodological detail available and the absence of direct clinical outcome validation (Level 5).

Xiao et al. [71] reported a case of ocular injury after cosmetic treatment of the eyelids with high-intensity macro- and microfocused ultrasound. A 40-year-old woman developed blurred vision, iris depigmentation, conjunctival hemorrhage, and lens opacities consistent with traumatic cataract after periocular exposure. This paper is highly significant from a safety standpoint because it documents direct ocular harm from ultrasound misapplication and reinforces the need for strict avoidance of direct eyelid treatment without proper protection and anatomical caution. While rare, such complications are potentially vision-threatening and should weigh heavily in periocular protocol design. The limitation is that risk magnitude cannot be estimated from a single case report (Level 4).

Khong et al. [72] performed a retrospective Malaysian study assessing combined HIFU and monopolar radiofrequency for skin tightening in 56 patients. Most participants showed clinically meaningful improvement, with 96.4% rated as improved or very much improved, and all reported only transient mild erythema immediately after treatment. No serious adverse events such as burns, swelling, numbness, or muscle weakness were documented. This study supports the practical use of dual-energy treatment in routine clinical settings, particularly where clinicians seek additive tightening effects without invasive downtime. Nevertheless, the retrospective design, lack of a comparator arm, and strong female predominance substantially limit the ability to draw definitive conclusions about superiority or broad external validity (Level 4).

Migliardi et al. [73] contributed a textbook chapter on alternative techniques for oculofacial rejuvenation. In the context of this review, the chapter is best interpreted as an expert-oriented overview of periocular rejuvenation strategies rather than as a source of original comparative outcome data. Its value lies in framing how ultrasound-based techniques may fit alongside other noninvasive and minimally invasive modalities in the management of oculofacial aging. Clinically, this is useful for understanding treatment positioning, especially in areas where patient selection and anatomical caution are paramount. The main limitation is the chapter format itself, which does not provide primary data adequate for independent evidence grading beyond expert guidance (Level 5).

Sanyal et al. [74] reviewed energy-based devices for facial skin conditions in patients with skin of color and concluded that MFU-V appears to be a safe option for treating skin laxity in Fitzpatrick III–VI skin. Because ultrasound energy is not selectively absorbed by epidermal melanin, the risk of postinflammatory dyspigmentation appears lower than with some light-based systems. Reported adverse effects, including edema, bruising, focal numbness, and pain, were transient and generally resolved within 1 month. This review is clinically important because it supports more inclusive MFU candidacy across diverse skin phototypes. The principal limitation is the scarcity of studies devoted specifically to the darkest phototypes, especially type VI skin (Level 5).

Ramirez et al. [75] presented a prospective, open-label, single-arm pilot study of superficial single-depth MFU-V combined with diluted calcium hydroxylapatite for lower-face skin quality in 12 women. Objective metrics demonstrated significant improvement in wrinkle depth and skin unevenness by week 24, and all participants were judged to have improved overall appearance as early as week 4. Patient satisfaction was high, and adverse events were mild and transient, consisting mainly of erythema, linear urticaria, edema, and bruising. The study is clinically relevant because it supports a synergistic approach in which superficial ultrasound and a biostimulatory filler jointly target crepiness and lower-face texture decline. The key limitation is the small, uncontrolled pilot design (Level 4) (Table 1).

Table 1. Summary of Literature on Microfocused Ultrasound in Aesthetic Medicine.

Author/Year	Study Design	Key Findings	Evidence Level
Sun et al., 2026 [19]	Comprehensive review and bibliometric overview	Focused ultrasound in aesthetics showed strong efficacy and safety, but the literature remained geographically concentrated in North America and East Asia, limiting global generalizability.	5
Preman et al., 2026 [20]	Narrative review	MFU-V was described as a safe and reliable nonsurgical lifting modality with established mechanisms and indications, although procedural pain remained a major barrier to patient adherence.	5
Li et al., 2026 [21]	Prospective clinical study	Objective quantitative assessment showed durable facial volumetric reduction and sustained skin tightening at 12 months with only mild transient adverse effects.	4
Lou et al., 2026 [22]	Prospective single-arm study	MFU produced high improvement rates for middle and lower face rejuvenation in Chinese women, with transient muscle pain but no major complications.	4
Rebelo-Marques et al., 2026 [23]	Hybrid review	The review emphasized personalization, safe treatment in skin of color, and the potential future role of AI-guided treatment planning in aesthetic ultrasound.	5
Nam et al., 2026 [24]	Retrospective comparative study	Compared with a microwave energy-based device, HIFU provided better sustained lifting and elasticity at 3 months, although the microwave device offered better early tolerability.	2b
Qi et al., 2026 [25]	Preclinical ex vivo porcine mechanistic study	Demonstrated that thermal accumulation and collagen remodeling were parameter-dependent, biologically supporting depth- and energy-specific MFU treatment planning.	5
Kono et al., 2026 [26]	Adverse-event review	Severe complications such as burns and nerve paresis were rare but linked to incorrect coupling and inaccurate anatomical depth targeting, underscoring the need for training.	5
Kumar et al., 2026 [27]	Bibliometric-systematic overview	Body rejuvenation and contouring with HIFU showed growing interest, but the evidence base remained limited and geographically concentrated, restricting protocol standardization.	5
Jin et al., 2026 [28]	Preclinical miniature pig study	Delivering MFU immediately before PLLA injection enhanced dermal remodeling and collagen production without destabilizing PLLA microspheres.	5
Faria et al., 2026 [29]	Narrative review	Procedural pain during MFU may reflect accurate targeting of innervated deep planes rather than simple intolerance, suggesting possible value as real-time biologic feedback.	5

Table 1. *Cont.*

Author/Year	Study Design	Key Findings	Evidence Level
Bastedo et al., 2026 [30]	Evidence review	Proposed a "Layering Energies" framework in which ultrasound, radiofrequency, and injectables are sequenced across tissue planes to optimize facial rejuvenation.	5
Zappia et al., 2026 [31]	Retrospective evaluation	Combined 675 nm laser and MFU was superior to either modality alone for facial aging at 6 months without major adverse events.	2b
Piccolo et al., 2026 [32]	Book chapter	Combining MFU with autologous regenerative therapies such as fat grafting or platelet-rich plasma was proposed to enhance both graft survival and tissue tightening.	5
Nazari et al., 2026 [33]	Book chapter	Provided a structured overview of HIFU indications, techniques, contraindications, and safety principles for office-based facial cosmetic surgery.	5
Jurcevic et al., 2026 [34]	Narrative multimodal review	Focused ultrasound was positioned within a layered rejuvenation strategy integrating fillers, collagen stimulators, botulinum toxin, and energy-based devices.	5
Song et al., 2026 [35]	Retrospective evaluation	Shallow-dermal linear HIFU improved fine wrinkles, skin roughness, and elasticity in Asian skin, supporting superficial applications for skin quality.	4
Vachiramon et al., 2025 [36]	Narrative review	MFU-V was framed as a regenerative device that promotes neocollagenesis and elastin remodeling rather than merely providing mechanical tightening.	5
Amiri et al., 2025 [37]	Systematic review and meta-analysis	Confirmed high patient satisfaction, meaningful objective improvement, and a favorable safety profile for MFU-V across clinical studies.	1a
Amiri et al., 2025 [38]	Systematic review	MFU-V combined with CaHA was found to be safe and synergistic, with superiority to monotherapy for jawline contour and dermal thickening.	1a
Pavicic et al., 2025 [39]	Narrative review	MFU-V improved superficial skin quality parameters including firmness, evenness, tone, and overall radiance beyond its deep lifting role.	5
Park et al., 2025 [40]	Practical review and experience paper	Described anatomy-guided MFU-V customization for Asian men, accounting for thicker dermis, heavier lower-face fat, and jawline-focused aesthetic goals.	5
Biskanaki et al., 2025 [41]	Comprehensive review	Most HIFU complications were mild and transient, but severe burns and nerve injuries remained possible and required vigilant risk management.	5
Wang et al., 2025 [42]	Prospective randomized split-face study	Combining MFU with microneedle fractional radiofrequency was superior to monotherapy for multilayered rejuvenation, improving tightening, pigmentation, and pores.	1b
Doyle et al., 2025 [43]	Pilot comparative sequence study	MFU-V performed first and followed by delayed hyperdilute CaHA produced better lifting and laxity reduction than alternative treatment sequencing.	2b
Modena et al., 2025 [44]	Systematic review and meta-analysis	Demonstrated significant improvement in sagging skin after MFU, while highlighting major heterogeneity in energy settings and scoring methods across studies.	1a
Suh et al., 2025 [45]	Retrospective safety study	An 18-year dataset of 1040 patients supported the long-term safety of combining MFU, monopolar radiofrequency, and injectables, with very low serious event rates.	2c

Table 1. *Cont.*

Author/Year	Study Design	Key Findings	Evidence Level
Heitzmann et al., 2025 [46]	Clinical case-series style report	Early clinical use of MFU in infraorbital rejuvenation showed visible improvement in under-eye laxity and fine lines, suggesting a nonsurgical alternative for early periocular aging.	4
Choi et al., 2025 [47]	Controlled clinical study	A deeper multi-depth MFU protocol achieved stronger and more durable temporary eyebrow lift and glabellar wrinkle reduction with good safety.	1b
Humphrey et al., 2025 [48]	Systematic review	Found little evidence that MFU-V compromises later facelift surgery, helping dispel concerns about prohibitive deep scarring.	1a
Lin et al., 2025 [49]	Global expert consensus	Established best-practice recommendations for MFU-V treatment of the abdomen and arms, including anatomy-based parameters and patient selection criteria.	5
Pharnchoowong et al., 2025 [50]	Controlled study	Superficial MFU performed too soon after intradermal botulinum toxin type A injection significantly reduced toxin efficacy and duration.	2b
Dicker et al., 2025 [51]	Comparative literature review	Commercial HIFU platforms showed marked heterogeneity in focal volume, energy delivery, and frequency, limiting direct generalization of protocols and outcomes.	5
Liu et al., 2025 [52]	Case report	Reported corneal leukoma with iridocyclitis after periocular MFU, illustrating the serious ocular risks of inaccurate treatment near the orbital region.	4
Barton et al., 2025 [53]	Book chapter	Summarized current cosmetic indications, patient selection, and safety principles for MFU, emphasizing the importance of visualization and anatomical awareness.	5
Pavicic et al., 2025 [54]	Perspective article	Highlighted expanding MFU-V use for arm and abdomen skin quality, particularly for mild body laxity and crepiness beyond the face.	5
Haykal et al., 2025 [55]	Systematic review	Supported the efficacy and safety of HIFU for skin tightening and body contouring, but emphasized the need for standardized outcomes and longer-term data.	1a
Pan et al., 2025 [56]	Prospective study	High-intensity macro-focused ultrasound significantly improved solar lentigo in Chinese patients, suggesting a novel superficial pigmentary application.	4
Doyle et al., 2025 [57]	Exploratory post hoc analysis	Age did not appear to substantially diminish the histologic biostimulatory response to combined CaHA and MFU-V within typical aesthetic age groups.	2c
Thadanukulwattana et al., 2025 [58]	Prospective randomized double-blinded intraindividual split-face study	Both 1.5-mm microfocused and 2.0-mm macrofocused ultrasound improved crow's feet and infraorbital laxity, with microfocused treatment showing somewhat better tolerability.	1b
Panithaporn, 2025 [59]	Case report	MFU with improved visualization was successfully used in a patient with multiple titanium facial implants, suggesting a possible advantage over some radiofrequency systems.	4
Welc et al., 2025 [60]	Narrative review	Reviewed HIFU applications for facial and neck rejuvenation, décolletage tightening, and body fat reduction, concluding that published outcomes were generally promising.	5
Weng et al., 2025 [61]	Retrospective observational study	Combination treatment with thread lifting and HIFU improved facial aging and jowl distance, with no clear sequence superiority between the two modalities.	4

Table 1. *Cont.*

Author/Year	Study Design	Key Findings	Evidence Level
Bukhari et al., 2024 [62]	Retrospective cross-sectional satisfaction study	About two-thirds of patients were satisfied or very satisfied after MFU-V, with better satisfaction in periocular and submental treatment areas.	2c
Chen et al., 2024 [63]	Rater-blinded prospective study	MFU achieved mean brow elevation of about 2.1 mm and clinically meaningful upper-face lifting at 6 months with a favorable safety profile.	2b
Al-Jumaily et al., 2024 [64]	Technical review	Linked focused ultrasound device physics, focal depth, and operational parameters to treatment efficacy, tolerability, and cost-efficiency in dermal applications.	5
Zhu et al., 2024 [65]	Prospective randomized controlled trial	A novel MFU platform produced clinically significant tightening and lower-face volumetric reduction using objective imaging and ultrasonographic assessment.	1b
Kim, 2024 [66]	Three-dimensional observational study	Immediate lifting effects after HIFU varied by facial aesthetic unit, with the greatest effect in the neck and the least in the forehead.	4
Wang et al., 2024 [67]	Prospective randomized split-face study	MFU combined with delicate pulsed light improved wrinkles, skin tone, erythema, barrier-related parameters, and elasticity more than MFU alone.	1b
Wang et al., 2024 [68]	Histological animal study	MFU caused immediate collagen contraction and later dermal thickening, increased collagen density, elastin, and septal thickening, supporting a remodeling mechanism.	5
Cirilo et al., 2024 [69]	Case report	MFU improved skin laxity in a patient with classic Ehlers–Danlos syndrome, suggesting a possible nonsurgical option in selected connective-tissue disorders.	4
Silva et al., 2024 [70]	In vitro study	PDO lifting threads appeared compatible with MFU because their melting point exceeded temperatures typically generated during treatment.	5
Xiao et al., 2024 [71]	Case report	Reported severe ocular injury, including lens opacity and iris damage, after cosmetic periocular macro- and microfocused ultrasound treatment.	4
Khong et al., 2024 [72]	Retrospective study	Combined HIFU and monopolar radiofrequency produced clinically meaningful skin tightening with only transient mild erythema and no serious adverse events.	4
Migliardi et al., 2024 [73]	Textbook chapter	Provided an expert overview of alternative periocular rejuvenation techniques and placed ultrasound-based modalities within broader oculofacial practice.	5
Sanyal et al., 2024 [74]	Review	Concluded that MFU-V appears safe for skin laxity in Fitzpatrick III–VI skin, with transient adverse effects and relatively low pigmentary risk compared with light-based devices.	5
Ramirez et al., 2024 [75]	Prospective open-label single-arm pilot study	Superficial single-depth MFU-V combined with diluted CaHA significantly improved lower-face wrinkle depth and skin unevenness, with high patient satisfaction and mild transient adverse events.	4

4. Discussion

The literature published between 2024 and 2026 reinforces microfocused ultrasound (MFU), including MFU with visualization (MFU-V), as a mature and clinically relevant modality for nonsurgical lifting and tightening, but it also makes clear that the field is now transitioning from proof-of-concept toward protocol refinement and multimodal integration. At the highest level, recent systematic reviews and meta-analyses consistently confirm that MFU produces meaningful improvement in mild-to-moderate skin laxity, with high patient satisfaction and a generally favorable adverse-event profile [37,38,55]. These higher-level syntheses are important because they validate the central role of focused ultrasound in aesthetic practice despite variability in device platforms, treatment settings, and outcome measures. However, the same reviews also expose a persistent methodological weakness in the literature: substantial heterogeneity in energy parameters, anatomical targets, follow-up duration, and investigator-assessed end points limits precise cross-study comparison and complicates the formulation of universally reproducible treatment algorithms [37,44,55]. Thus, the contemporary evidence base is strong enough to support clinical use, yet still insufficiently standardized to define a single "best" protocol.

A key strength of the recent evidence is the growing use of objective measurements that move the field beyond subjective photographic impressions alone. Prospective studies by Li et al. and Zhu et al. employed quantitative instruments, three-dimensional imaging, volumetric analysis, and ultrasound-derived skin measurements, demonstrating durable facial tightening and lower-face volume reduction after MFU treatment [21,65]. These findings are important because they support the interpretation that ultrasound-induced improvement is not merely a transient effect caused by edema or photographic bias, but rather reflects structural remodeling. Histologic and mechanistic studies further support this conclusion. Wang et al. documented collagen contraction immediately after treatment and subsequent dermal thickening, increased collagen density, enhanced elastin, and thickened adipose septa in porcine skin [68]. Similarly, Qi et al. showed a parameter-dependent relationship between thermal accumulation and collagen remodeling, biologically substantiating the need for precise depth and energy selection [25]. Taken together, these data strengthen the regenerative model of MFU, whereby localized thermal coagulation points initiate neocollagenesis and tissue reorganization over time rather than generating only immediate mechanical shrinkage [25,36,68].

Clinically, the strongest and most consistent indication remains treatment of the lower face and neck. Recent prospective and randomized studies reported improvement in facial contour, skin laxity, and submental definition, especially in the middle and lower face [21,22,65]. Kim et al.'s three-dimensional analysis is particularly instructive because it suggests that lifting responses vary by facial aesthetic unit, with the neck, posterior cheek, and mandibular region showing greater measurable repositioning than the forehead [66]. This supports the prevailing clinical impression that MFU performs best in areas with mild-to-moderate ptosis, sufficient tissue thickness, and structurally meaningful deep targets. The data therefore align with current practice patterns in which ultrasound is most predictably effective for jawline softening, early jowl formation, and cervical laxity, while more limited effects are expected in severely redundant tissue or in regions where superficial aging predominates [21,22,66]. Real-world satisfaction data also appear consistent with this pattern, as Bukhari et al. found greater patient satisfaction in periocular and submental treatments and when procedures were performed by more experienced physicians [62]. This implies that both anatomical suitability and operator expertise remain major determinants of perceived success.

Upper-face and periocular applications are increasingly represented in the literature, but they also reveal the narrow therapeutic window of focused ultrasound near delicate structures. Choi et al. showed that multi-depth protocols can improve eyebrow elevation and glabellar rhytids, while Chen et al. demonstrated measurable brow lifting with upward and lateral-oblique tissue displacement over 6 months [47,63]. These studies support the concept that carefully delivered MFU can achieve modest but clinically visible upper-face rejuvenation. Infraorbital and crow's feet treatment has also shown promise, with Heitzmann et al. and Thadanukulwattana et al. reporting improvements in under-eye laxity, rhytids, and elasticity [46,58]. Nevertheless, the periocular literature must be interpreted with caution because the region is anatomically unforgiving. Case reports of corneal leukoma with iridocyclitis and of broader ocular injury, including lens opacity and iris damage, underscore that improper treatment too close to the globe can have vision-threatening consequences [52,71]. Consequently, although upper-face and infraorbital indications are clinically attractive, they demand strict respect for orbital boundaries, conservative depth selection, meticulous visualization, and rigorous training. The expanding evidence here should therefore be viewed as enabling but not liberalizing periocular practice.

One of the most notable developments in the year 2024–2026 literature is the reframing of MFU from a pure lifting device to a skin-quality technology. Narrative reviews and clinical studies increasingly describe benefits in texture, firmness, fine lines, tone, and "glow," particularly when superficial transducers are used [35,39]. Song et al. showed that shallow-dermal linear HIFU improved fine wrinkles, roughness, and elasticity in Asian skin, while Ramirez et al. demonstrated that single-depth superficial MFU-V combined with diluted calcium hydroxylapatite (CaHA) improved wrinkle depth and lower-face unevenness [35,75]. These data broaden the conceptual utility of ultrasound beyond the classic SMAS-targeting model and suggest that superficial dermal injury patterns may have practical value for crepiness and textural decline. However, this expansion also complicates terminology and expectations. The literature now encompasses deep lifting, superficial rejuvenation, and hybrid protocols using different transducer depths for different goals, yet many studies still report outcomes under the same umbrella labels of "rejuvenation" or "tightening" [35,39,53]. Future work should distinguish more clearly between structural lifting endpoints and superficial skin-quality endpoints so that clinicians can better match protocol to indication and patients can receive more accurate counseling regarding likely benefits.

Combination therapy is arguably the defining theme of the current evidence base. The recent literature increasingly positions MFU as one component of layered facial restoration rather than as a standalone treatment [30,31,34]. The most compelling evidence concerns synergy with biostimulatory injectables, especially CaHA. A systematic review by Amiri et al. concluded that MFU-V combined with CaHA is safe and synergistic, with particular value for jawline contour and dermal thickening [38]. Pilot human data further suggest that treatment sequence matters: Doyle et al. found that MFU-V first followed by delayed hyperdilute CaHA produced better lifting and laxity reduction than alternative sequencing [43]. Ramirez et al. likewise reported favorable skin-quality outcomes with superficial MFU-V plus diluted CaHA [75]. Preclinical work by Jin et al. extends this logic to poly-L-lactic acid (PLLA), indicating that MFU delivered before PLLA may augment remodeling without destabilizing microspheres [28]. Collectively, these findings suggest that ultrasound can serve as a structural and biological primer that enhances subsequent biostimulatory responses, but the human evidence remains limited by small sample sizes and short follow-up [28,38,43,75]. Even so, the trend toward evidence-backed sequencing marks an important advance over purely anecdotal multimodal practice.

Other combination strategies are also gaining support. Wang et al. showed in a randomized split-face study that combining MFU with microneedle fractional radiofrequency improved tightening, pigmentation, and pore size more effectively than monotherapy, reflecting the benefit of targeting different tissue planes in the same treatment course [42]. Likewise, MFU combined with delicate pulsed light improved not only wrinkles and laxity but also tone, erythema, and barrier-related parameters, underscoring the value of pairing deep structural treatment with more superficial optical rejuvenation [67]. Retrospective studies suggest potential additive benefit from pairing ultrasound with a 675 nm laser, monopolar radiofrequency, or thread lifting [31,61,72]. Book chapters and reviews further extend this paradigm to platelet-rich plasma, autologous fat grafting, and broader pan-facial strategies integrating fillers, collagen stimulators, botulinum toxin, and energy-based devices [32,34]. Yet combination therapy also introduces new sequencing risks. Pharnchoowong et al. found that superficial MFU can reduce the efficacy and longevity of intradermal botulinum toxin when performed too soon after injection, indicating that ultrasound should generally precede toxin placement when same-region treatment is planned [50]. Thus, the future of MFU likely lies in multimodal integration, but its success will depend not only on identifying synergistic pairings, but also on clarifying optimal timing and tissue-plane logic.

Body indications represent another expanding frontier, though the quality of evidence remains lower than for facial applications. Reviews, expert consensus, and bibliometric analyses indicate growing interest in the abdomen, arms, and broader body contouring applications of HIFU and MFU-V [27,49,60]. The most mature recent contribution is the global expert consensus by Lin et al., which provides best-practice guidance for the abdomen and arms, including anatomical cautions, patient selection, and parameter considerations [49]. This is valuable because body treatment introduces different skin thicknesses, broader treatment fields, and different risk profiles than facial work. At the same time, the literature remains dominated by expert opinion, narrative reviews, and heterogeneous clinical endpoints [27,49,55]. While systematic review data broadly support safety and efficacy for body tightening and contouring, they also emphasize the absence of standardized metrics and long-term durability data [55]. Therefore, body applications should currently be regarded as promising but less evidence-settled than facial lifting, especially when claims extend beyond mild laxity to true contour remodeling.

The literature also highlights the importance of personalization across sex, ethnicity, anatomical variability, and special clinical circumstances. Park et al. proposed customized MFU-V protocols for Asian men, accounting for thicker dermis, heavier lower-face fat compartments, and the aesthetic preference for sharper jawline definition [40]. Reviews addressing skin of color conclude that MFU is particularly advantageous in Fitzpatrick III–VI skin because ultrasound energy is not absorbed by epidermal melanin, thereby lowering the risk of pigmentary complications compared with many light-based systems [23,74]. This broadens inclusivity and may help explain the strong representation of East Asian cohorts in recent clinical studies [24,35,40]. Special scenarios are also beginning to appear. Panithaporn reported successful treatment in a patient with multiple titanium facial implants using an updated visualization-enabled platform [59], and Cirilo et al. described a case in classic Ehlers–Danlos syndrome [69]. Although these reports are too limited to define practice standards, they suggest that visualization and anatomy-guided planning may expand candidacy in complex patients who were previously considered poor candidates for energy-based rejuvenation.

Safety remains one of the strongest advantages of focused ultrasound, but the newer literature makes clear that safety is conditional rather than automatic. Large retrospective datasets and systematic reviews confirm that most adverse events are mild and transient, typically including erythema, edema, discomfort, tingling, and short-lived tenderness [37,41,72]. This is reassuring and consistent with the longstanding reputation of MFU as a low-downtime modality. However, recent reviews of adverse events and case reports of severe complications provide an essential corrective to overly casual use [26,41,71]. Severe burns, nerve injury, and ocular trauma are rare, but they are clinically consequential and almost always linked to poor coupling, inappropriate depth selection, or breach of anatomical safety zones [26,41]. The reassurance offered by Humphrey et al. that MFU does not appear to compromise future facelift surgery is important, because it addresses a practical concern among both surgeons and patients considering MFU as a bridge therapy [48]. Still, the field should resist equating rarity of severe complications with permissiveness. The message emerging from the literature is that focused ultrasound is safe in trained hands, not safe irrespective of operator skill.

A final major issue is standardization. Recent reviews repeatedly note substantial differences among commercial HIFU and MFU platforms in frequency, focal depth, focal volume, and energy delivery [51,64]. This matters because efficacy and safety data derived from one device cannot be blindly extrapolated to another. It also explains some of the apparent inconsistency in outcomes across the literature. Therefore, the field now needs fewer broad affirmations that MFU "works" and more rigorous trials that compare depths, sequences, devices, and patient subgroups using standardized objective endpoints. Particularly needed are multicenter randomized studies with longer follow-up, body-region–specific protocols, validated patient-reported outcomes, and clearer adverse-event reporting frameworks. Such work would allow focused ultrasound to progress from a highly effective but technique-dependent modality to a truly protocol-driven standard of care.

5. Conclusions

Microfocused ultrasound remains one of the most versatile noninvasive technologies in aesthetic medicine, with its strongest evidence supporting treatment of mild-to-moderate laxity of the lower face and neck. Recent literature shows that its role is expanding beyond deep lifting toward skin-quality improvement, upper-face refinement, and carefully selected body indications. The most important contemporary shift is the move toward multimodal use, especially with biostimulatory injectables and complementary energy-based devices, where sequencing appears critical to outcome quality. At the same time, this expanded use makes operator expertise, anatomical precision, and device-specific understanding more important than ever. Future progress will depend on standardized protocols, better comparative trials, longer follow-up, and stricter safety frameworks for high-risk anatomical zones.

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