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Major considerations and clinical findings of micro-focused ultrasound and collagen biostimulation in human skin aesthetics: a systematic review

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Abstract

Introduction: As a safe and effective alternative for addressing aesthetic skin concerns, studies have shown that transcutaneous micro-focused ultrasound (TMU)—a device approved by the Food and Drug Administration (FDA)—can be beneficial for the noninvasive regeneration of the skin's collagen fibers. **Objective:** It was to describe and present clinical results on the skin after the use of micro-focused ultrasound to improve the aesthetics of human skin. **Methods:** The search was carried out from May to June 2026 in the Embase, Scopus, PubMed, Science Direct, SciELO, and Google Scholar databases. **Results and conclusion:** A total of 139 articles were found, and 19 articles were included in the systematic review. Most studies showed homogeneity in their results, according to Chi-Square analysis, with X^2=82.5%>50%. It was evidenced that TMU is an effective method for facial rejuvenation and firming. High-resolution MFU, when combined with diluted calcium hydroxyapatite, polycaprolactone, and/or poly-L-lactic acid, is effective in addressing skin laxity and yields significant aesthetic improvement. The sequential application of MFU immediately prior to poly-L-lactic acid enhances dermal remodeling more effectively than either treatment alone, without compromising poly-L-lactic acid stability.

Keywords: Skin. Aesthetics. Regeneration. Collagen. Micro-focused ultrasound. Dermatology.

Introduction

As a safe and effective alternative for addressing aesthetic skin concerns, studies have shown that transcutaneous micro-focused ultrasound (MFU)—a device approved by the Food and Drug Administration (FDA)—can benefit the non-invasive regeneration of skin collagen fibers [1-4]. MFU can be focused on the subcutaneous tissue, where the temperature briefly exceeds 60°C, producing small points of thermal coagulation (<1 mm³) at depths of up to 5 mm within the mid-reticular dermis. The papillary dermal and epidermal layers of the skin remain unaffected [3,4].

In this context, a device combining MFU with high-resolution ultrasound imaging (high-resolution MFU) enables the visualization of tissue planes at depths of up to 8 mm, allowing the user to see exactly where the MFU energy will be applied [5-10]. By using different transducers, high-resolution MFU treatment can be tailored to each patient's unique physical characteristics—adjusting the energy and focal depth of the emitted ultrasound—to achieve non-invasive contraction and lifting of sagging skin [4,11-15].

Nevertheless, high-resolution MFU treatment protocols continue to be optimized to minimize or eliminate treatment-related adverse events, such as transient erythema, edema, and occasional bruising [3,4,16-19]. Although high-resolution MFU is best suited for patients with mild to moderate skin and soft-tissue laxity, the clinical evidence remains limited regarding its use in aesthetic skin improvement. Furthermore, clinical studies have demonstrated a synergistic effect when combining high-resolution MFU with poly-L-lactic acid and fractional CO_2 laser, or with diluted calcium hydroxylapatite [8-12,20].

Therefore, the present study aimed to describe and present clinical skin outcomes following the use of micro-focused ultrasound for aesthetic improvement, addressing the limited clinical evidence on its use in this setting.

Methods

Study Design

This study followed the international model for systematic reviews, adhering to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: May 14, 2026. The AMSTAR-2 (A Measurement Tool to Assess Systematic Reviews) standards for methodological quality were also followed. Available at: https://amstar.ca/. Accessed on: May 14, 2026.

Data Sources and Search Strategy

The literature search process was conducted from May to June 2026 using the Web of Science, Scopus, Embase, PubMed, ScienceDirect, SciELO, and Google Scholar databases. Articles published up to 2026 were included, utilizing the following descriptors (Health Sciences Descriptors – DeCS/MeSH Terms): *"Skin. Aesthetics. Regeneration. Collagen. Micro-focused ultrasound. Dermatology"* along with the Boolean operators "AND" between descriptors (MeSH Terms) and "OR" between related terms.

Study Quality and Risk of Bias

Study quality was assessed using the GRADE instrument; randomized controlled trials, prospective controlled clinical trials, and systematic reviews with meta-analyses were classified as providing the highest level of scientific evidence. Risk of bias was analyzed using the Cochrane tool. Methodological quality for each study was interpreted according to the AMSTAR-2 instrument.

Results and Discussion

Summary of Literature Findings

A total of 139 articles were identified. Initially, duplicate articles were removed. Subsequently, abstracts were evaluated, and a further exclusion step was performed to remove articles that did not address the study topic, resulting in a final selection of 87 articles. A total of 42 articles were evaluated in full, and 19 articles were included and analyzed in this systematic review (Figure 1). Based on the Cochrane risk-of-bias tool, the overall assessment identified 23 studies with a high risk of bias and 22 studies that did not meet GRADE and AMSTAR-2 criteria. The majority of the studies showed homogeneity in their results, according to the Chi-square analysis (X^2 = 82.5% > 50%).

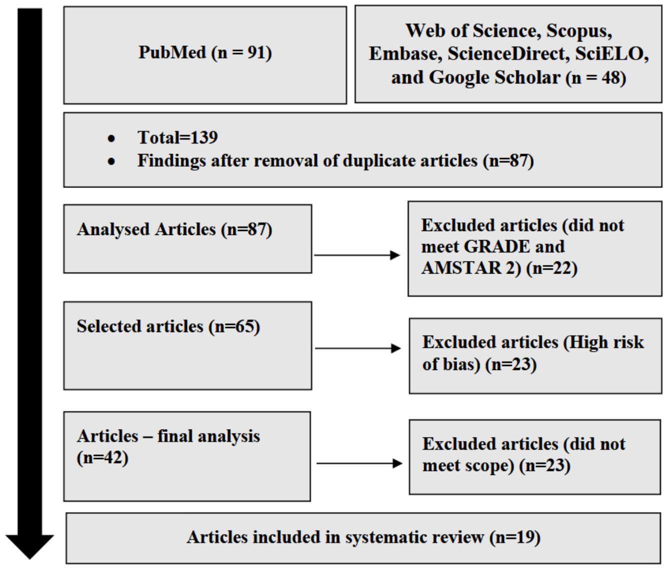

Figure 1. Flowchart showing the article selection process. Source: Own Authorship.

Figure 2 presents the results regarding the risk of bias across the studies using a funnel plot, showing the calculation of effect size (magnitude of difference) via Cohen's d. Precision (sample size) was determined indirectly as the inverse of the standard error (1/Standard Error). The plot exhibited a symmetrical pattern, suggesting no significant risk of bias among either studies with small sample sizes (lower precision) - shown at the base of the plot - or studies with large sample sizes - shown at the top.

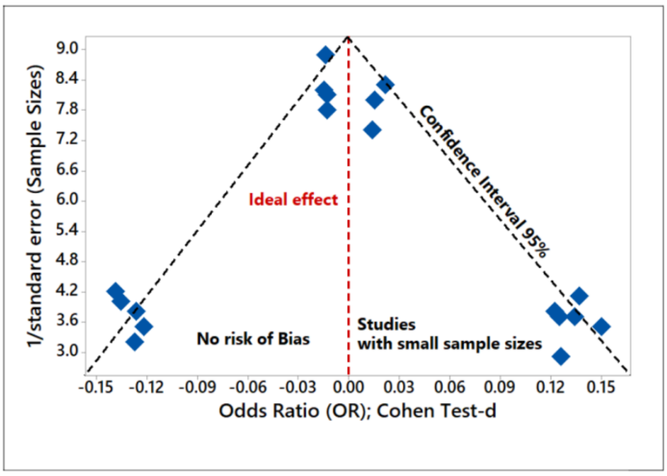

Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the small-sample-size studies shown at the bottom of the plot. Studies with high confidence and strong recommendations are shown at the top of the plot (n=19 studies). Source: Own authorship.

Major Clinical Findings

Overall, studies on MFU for facial rejuvenation and tightening demonstrated efficacy using the Global Aesthetic Improvement Scale (GAIS), showing an overall response rate at 90 days post-intervention. The proportions of satisfied or very satisfied patients were significant. Pain was assessed on a 10-point scale, with an overall mean score of 3.10 [2].

Jin et al. (2026) [21] confirmed that poly-L-lactic acid (PLLA) and MFU are widely used for skin rejuvenation, each promoting collagen remodeling through distinct mechanisms. These authors demonstrated that PLLA alone increased dermal thickness by 23.7% and raised the type III/I collagen ratio to 0.79 ± 0.06 ($p<0.01$). MFU alone primarily promoted type I collagen (ratio: 0.39±0.04) and improved fiber alignment. Combined treatment using MFU immediately prior to PLLA yielded the best results: dermal thickness increased by 35.2%, and the type III/I collagen ratio reached 0.92 ± 0.05 (both with $p < 0.01$). This group also exhibited denser elastin fibers, well-structured adipose septa, and a more compact collagen morphology upon SEM analysis. MFU did not accelerate PLLA degradation or increase inflammation; there was no significant difference in microsphere size or inflammatory infiltration compared to PLLA alone ($p > 0.05$). These findings corroborate the clinical potential and safety of this combined approach, offering evidence-based guidance for optimizing skin rejuvenation protocols, as supported by other authors [22-30].

Lou, Hsieh, and Cai (2026) [31] evaluated the efficacy and safety of MFU for rejuvenating the mid- and lower face in Chinese patients through a 6-month prospective study. Twenty Chinese patients with facial laxity were included. All underwent a single treatment session using the Peninsula MFU device. The validated 5-point Investigator Global Aesthetic Improvement Scale (IGAIS) was used. Based on the combined IGAIS scores from both evaluators, 100% of patients showed improvement at 3 and 6 months. Peak response was observed at 3 months, with 32.5% classified as "much improved" and 57.5% as "significantly improved." The quantitative metric for the mandibular area ("Area x") showed a statistically significant reduction compared to baseline at 1 month ($p < 0.0001$) and 3 months ($p = 0.0116$), indicating tissue lifting. Overall patient satisfaction was high (100% satisfied at 3 months). No serious complications occurred.

According to Fabi (publications from 2014, 2015, and 2020), high-resolution UMT demonstrated significant aesthetic improvement for up to 180 days after a single treatment in women with moderate to severe wrinkles [32-34]. Furthermore, the author demonstrated that high-resolution UMT targets the facial superficial musculoaponeurotic system (SMAS), achieving non-invasive tightening and lifting of sagging skin.

In this context, Montes and Santos (2019) [35] interviewed 52 patients undergoing treatment on the lower face and submental area. A total of 41% reported that their treatment results met or exceeded their expectations, although 52% required a follow-up consultation. Furthermore, high-resolution MFU must be applied to the SMAS, subcutaneous tissue, and deep dermis using the three available transducers. To achieve an optimal lifting effect, collagen in all these layers must be stimulated.

In this regard, a study protocol by Araco (2020) [36], published in the Aesthetic Surgery Journal, involved a single treatment session; the heat released in a targeted layer spreads to levels above and below, thereby increasing collagen stimulation. Thus, high-resolution MFU delivered in a single session using three modalities appears superior to standard isolated therapy involving three separate modalities, particularly given the observed increase in hemoglobin levels, which suggests that high-resolution MFU improves vascularization in the target tissue. Moreover, no complications were observed following treatment, and the skin surface remained undamaged.

Also, a retrospective clinical study conducted by Casabona and Pereira (2017) [37] evaluated the effects of high-resolution MFU (Ultherapy®) combined with diluted calcium hydroxylapatite (CaHA; Radiesse®) on the appearance of cellulite and on neocollagenesis. Twenty women (aged 18–55) with skin laxity and moderate-to-severe cellulite on the buttocks and thighs were included. High-resolution MFU was applied using 4 MHz and 7 MHz transducers (25 lines/transducer/site), immediately followed by a subdermal injection of CaHA (1 mL per buttock or thigh). Photographs taken at baseline and at 90 days were evaluated by two independent, blinded assessors using a 5-item cellulite severity scale. Both assessors reported statistically significant improvements compared to baseline for each item on the cellulite severity scale ($p < 0.001$), with a 4.5-point improvement in the mean overall score ($p < 0.001$) following a single treatment with high-resolution UMT and CaHA. At 90 days, histological analysis showed peak neocollagenesis in samples treated with the 1:1 dilution, whether with CaHA alone or in combination with high-resolution UMT. The greatest conversion of type III collagen to type I collagen at month 3 occurred in samples injected with 1:1 and 1:0.6 CaHA dilutions without subsequent high-resolution UMT treatment. Both procedures were well tolerated, and participant satisfaction was high. Therefore, combination treatment with high-resolution UMT and diluted CaHA is effective for improving skin laxity and the appearance of cellulite on the buttocks and upper thighs.

Finally, a randomized controlled clinical study evaluated the clinical efficacy and tolerability of high-resolution UMT combined with CaHA filler diluted with normal saline for the correction of age-related changes, as well as patient satisfaction with this combination therapy. Immunohistochemical analysis was performed on 20 subjects indicated for a lower face, neck, and décolletage lift. Over the course of five visits, CaHA diluted with normal saline (1:2) was injected subdermally into the lower third of the face, the neck, the décolletage, and the lower abdominal quadrant. High-resolution UMT was performed on the lower third of the face, neck, and décolletage, as well as the right lower abdominal quadrant. The procedures were well tolerated, and participant satisfaction was high. CaHA injections combined with high-resolution MFU treatment stimulated neoangiogenesis, led to increased cellular synthetic activity and a marked increase in collagen and elastin fibers, and resulted in remodeling of the superficial and deep dermal layers. An improvement in the severity of age-related changes was observed in all areas studied [38].

Limitations

Further multicenter, randomized studies with large sample sizes are needed to determine optimal treatment parameters in the future.

Conclusion

It was concluded that MFU is an effective method for facial rejuvenation and firming. High-resolution MFU, when combined with diluted calcium hydroxyapatite, polycaprolactone, and/or poly-L-lactic acid, is effective in addressing skin laxity and yields significant aesthetic improvement. The sequential application of MFU immediately prior to poly-L-lactic acid enhances dermal remodeling more effectively than either treatment alone, without compromising poly-L-lactic acid stability.

CRediT

Author contributions: Conceptualization; Formal Analysis; Investigation; Methodology; Project administration; Supervision; Writing - original draft and Writing- review & editing- Dennise Jiménez Cervantes, and Andréia Borges Scriboni.

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Ethical Approval

Not applicable.

Informed Consent

Not applicable.

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Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate@.

Application of Artificial Intelligence (AI)

Not applicable.

Peer Review Process

It was performed.

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