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Reduction of Adipose Tissue and Improvement of Skin Laxity Using Combined PDLLA, Ultrasound, and Radiofrequency: A Prospective Case Series

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Abstract

Background: Non-invasive body contouring technologies, including ultrasound (US) and radiofrequency (RF) are widely utilized for body contouring procedures that target and modify adipose tissue, leading to desired aesthetic outcomes such as body shaping and tightening effects. The combination of these modalities, alongside biostimulator fillers such as poly-D,L-lactic acid (PDLLA), represents a novel multimodal approach for body contouring.

Objective: To evaluate the efficacy and safety of a combined PDLLA, ultrasound, and RF treatment protocol for reduction of adipose tissue and improvement of skin laxity in the buttocks.

Methods: Ten female patients (mean age 45.6 ± 6.4 years) with localized adiposity and skin laxity in the gluteal region were enrolled in a prospective, open-label case series. Patients received bilateral PDLLA-based filler injections, followed 6 weeks later by three sessions of combined US and RF treatment at two-week intervals. Outcomes included changes in fat layer thickness (echography), tissue elasticity (elastography), and patient satisfaction at 3 months post-treatment.

Results: All patients demonstrated significant improvement. Mean reduction in total fat layer thickness was 54% ($p<0.001$). Tissue elasticity improved by 55% in the areolar layer and 67.5% in the lamellar layer ($p<0.001$). Patient satisfaction was high (mean 3.9 ± 0.7 on a 5-point Likert scale). No adverse events were reported.

Conclusion: The combination of PDLLA, US, and RF is a safe and effective multimodal approach for reducing adipose tissue and improving skin laxity in the buttocks. Larger controlled studies with longer follow-up are warranted.

Keywords: Ultrasound; PDLLA; Radiofrequency; Adipose tissue; Skin laxity; Body contouring

Introduction

In recent years, non-invasive body contouring procedures have gained popularity as asafer and more convenient alternative to surgical options [1]. While liposuction remains a commonly performed cosmetic surgery, it carries significant risks and requires a lengthy recovery period, potentially leading to asymmetrical results. To address these limitations, various non-invasive modalities have been developed, such as cryolipolysis, radiofrequency, focused ultrasound, laser energy, and high-intensity focused electromagnetic technology [2,3]. These techniques have become increasingly sought after due to their safety profile, minimal recovery time, and reduced cost.

Ultrasound-based technology utilized in body contouring procedures can induce adipose disruption via thermal coagulation or mechanical effects, depending on frequency and delivery mode.

High-frequency US generates heat that induces coagulative necrosis of adipocytes, leading to their destruction, and also stimulates collagen remodeling within the tissue matrix [4]. Notably, maintaining tissue temperatures above 56°C facilitates the necrotic process while preserving the integrity of surrounding nerves and vessels [5]. By effectively targeting both fat cells and collagen, this approach brings about gradual skin tightening and reduction of adipose tissue [5]. Focused US, on the other hand, utilizes low-frequency US to mechanically disrupt the adipocytes without relying on thermal effects [4,6]. These ultrasound-based procedures selectively target adipose tissue while sparing surrounding tissue, nerves and blood vessels. This targeted approach helps minimize damage to non-targeted structures and reduces the risk of complications.

Radiofrequency (RF) technology for body contouring is a non-invasive procedure that utilizes RF energy to target and modify adipose tissue, resulting in body shaping and tightening effects [7,8]. First, RF energy penetrates the skin and heats the adipose tissue without causing damage to the epidermis. This selective heating effect is achieved by the preferential absorption of RF energy by water molecules in the adipose tissue and promotes the breakdown of fat cells, reducing their volume. Secondly, the heating effect promotes collagen production and remodeling within the skin and underlying tissue.

Recent approaches have explored the synergistic combination of US and RF for treating subcutaneous fat9. In this co-treatment a synergistic effect had been proposed, the acoustic pressure caused by the ultrasound selectively destroys adipocytes, while RF increases local metabolism to expel fat cell remnants while promoting collagen contraction and skin tightening [9,10]. Preliminary data show that this treatment is safe and efficiently reduces abdominal fat [10].

In parallel, biostimulatory fillers such as PDLLA have gained attention for their ability to induce collagen synthesis and restore structural support. Subdermal fillers allow the restoration of volume loss by filling the area concerned, correcting wrinkles, and improving body and facial contours. The number of cosmetic procedures with subdermal fillers has risen from 1.6 million in 2011 to 3.4 million in 2020. The types of off-the-shelf fillers include Hyaluronic Acid (HA), Calcium hydroxylapatite (CaHA), Poly-L-lactic acid (PLLA), and Polymethylmethacrylate (PMMA) [9-12]. Lenisna is a hybrid filler comprised of HA and PDLLA. HA draws in moisture for visibly plumper skin, while PDLLA stimulates collagen production in the skin. Upon injection, the PDLLA particles replace lost collagen and reinforce the skin structure. Over time, the appearance of fine lines and wrinkles will decrease as the skin's collagen levels rise.

Buttock augmentation improves the volume, shape, and contour of the buttocks through fat grafting, silicone implants, or a combination of these two. However, these procedures often require anesthesia and carry serious risks. The only nonsurgical buttock augmentation treatment currently available is Sculptra, a dermal filler based on PLLA. However, the procedure requires 2-3 injections; results are visible only after 4-6 months and are temporary. Furthermore, the average cost of this treatment is high.

The present study evaluates a multimodal treatment strategy combining PDLLA injection with subsequent US and RF therapy for non-invasive buttock contouring.

Methods

Ten healthy female patients that presented an excess of local adipose tissue and skin laxity at the buttocks area and desired to tighten gluteus skin and were able to comply with all requirements of the protocol were treated at the Elite Laser Clinic, Madrid, Spain. Exclusion Criteria included pregnancy, current anticoagulant therapy, previous treatments in the area intended for treatment.

Data collection and management were carried out in compliance with applicable data protection regulationsAll patients provided written consent.

Protocol: At baseline, each patient was injected with one vial of Lenisna (Poly-D,L-lactic Acid+HA, Raum Medical, Seoul, Korea) on each side of the buttocks. Six weeks following the PDLLA injection, treatments with Alma Prime X (Alma Lasers, Caesarea, Israel) were initiated. Patients underwent three treatment sessions at 2-week intervals. Each subject completed a study schedule including screening, baseline, treatment, and follow-up visits. Ultrasound was administered using the UltraWave applicator (Alma Lasers, Caesarea, Israel) with a power levels of 5-8 W, with an operating frequency of 10 Hz, and high vacuum, for 15 min per session. This was followed by RF treatment, using the Unibody applicator for 15 minutes delivering a cumulative energy of 70 kJ at power levels ranging from 140 to 200 W in sub-deep or deep modes.

Outcome Measures: Each subject was evaluated at baseline and at three months following the final treatment session.

Treatment efficacy was measured using the following:

Subject-reported outcomes: Changes in buttock appearance as perceived by the subject at the three months follow-up visit using a Likert-scale of 1 to 5 (not satisfied, little satisfied, moderately satisfied, quite satisfied, very satisfied).

Fat layer thickness: Quantitative assessment using ultrasound (echography) with a 6-18 MHz linear probe (Mylab Class C, Esaote). Images were obtained at baseline and at the three-month follow-up visit.

Subcutaneous tissue elasticity: Evaluation by elastography using a 6-18 MHz linear probe. Images of the area in each patient at baseline and at the three-month follow-up visit. Tissue was graded on a 4-point scale: 1 (green, highest elasticity, soft) to 4 (red, lowest elasticity, hard): 4 (red)/3 (orange)/2 (blue)/1 (green).

Safety was monitored by recording adverse events during the treatment course and the follow-up period.

Patient satisfaction was recorded at follow-up using a 5-point Likert scale: (1) very satisfied, (2) somewhat satisfied, (3) neutral, (4) somewhat dissatisfied, and (5) very dissatisfied [13].

Results

This case report series consisted of 10 female patients with a mean age of 45.6 ± 6.4 years. Outcomes were assessed by comparing baseline measurements with those obtained at three months following the final treatment session.

Ultrasound evaluation demonstrated a reduction in fat layer thickness in all patients, with a mean decrease of 54.0 ± 6.96% ($p < 0.001$). The areolar fat layer thickness decreased by 54.2 ± 9.46% ($p < 0.001$), while the lamellar fat layer thickness decreased by 52.5 ± 11.84% ($p < 0.001$) (Table 1, Figure 1).

Elastography findings indicated improvement in tissue elasticity, with the lamellar layer showing a 67.5 ± 12.08% improvement and the areolar layer a 55.0 ± 15.8% improvement (both $p < 0.001$) (Table 2, Figure 2).

Patient satisfaction scores ranged from 3 to 5, with a mean of 3.9 ± 0.7 (Table 2). Representative clinical images are presented in Figures 3, 4.

No adverse events were reported during the treatment or follow-up period.

Patient	**Full fat layer**			**Areolar fat layer**			**Lamellar fat layer**		
	Pre	*Post*	*Decrease (%)*	*Pre*	*Post*	*Decrease (%)*	*Pre*	*Post*	*Decrease (%)*
1	19.9	10.3	*48*	11.4	5.4	*53*	8.4	4.9	*42*
2	16.1	8.2	*49*	5.4	3.3	*39*	10.7	4.8	*55*
3	20.3	6.7	*67*	5.4	2.4	*56*	15	4.1	*73*
4	33.1	14.7	*56*	13	5.1	*61*	20	9.5	*52*
5	17.1	9.7	*43*	6	3.6	*40*	11	6	*45*
6	30.6	12.9	*58*	11.6	5.8	*50*	18.9	7.1	*62*
7	11.6	4.9	*58*	5.6	2	*64*	5.8	3	*48*
8	36.5	14.6	*60*	19.3	8.3	*57*	17.4	6.2	*64*
9	24.9	12.7	*49*	11.3	3.6	*68*	13.4	9.1	*32*
10	31.9	15.1	*53*	12.7	5.7	*55*	19	9.5	*50*
Average			*54*			*54*			*52*
P (paired t-test)			$1.3x10^{-5}$			$7.7x10^{-5}$			$4.4x10^{-5}$

Table 1: Changes in fat layer following treatment.

Patient	**Areolar fat layer**			**Lamellar fat layer**			**Satisfaction**
	Pre	*Post*	*Decrease (%)*	*Pre*	*Post*	*Decrease (%)*	
1	4	1	*75*	4	1	*75*	*3*
2	4	2	*50*	4	2	*75*	*3*
3	4	2	*50*	4	1	*75*	*4*
4	4	2	*50*	4	1	*75*	*4*
5	4	2	*50*	4	1	*75*	*5*
6	4	1	*75*	4	1	*75*	*4*
7	4	1	*75*	2	1	*50*	*4*
8	4	2	*50*	4	2	*50*	*3*
9	4	3	*25*	4	1	*75*	*5*
10	4	2	*50*	4	2	*50*	*4*
Average			*55*			*67.5*	*3.9*
P (paired t-test)			$8x10^{-7}$			$4.6x10^{-7}$	

Table 2: Changes in fat layer elasticity following treatment and patient satisfaction.

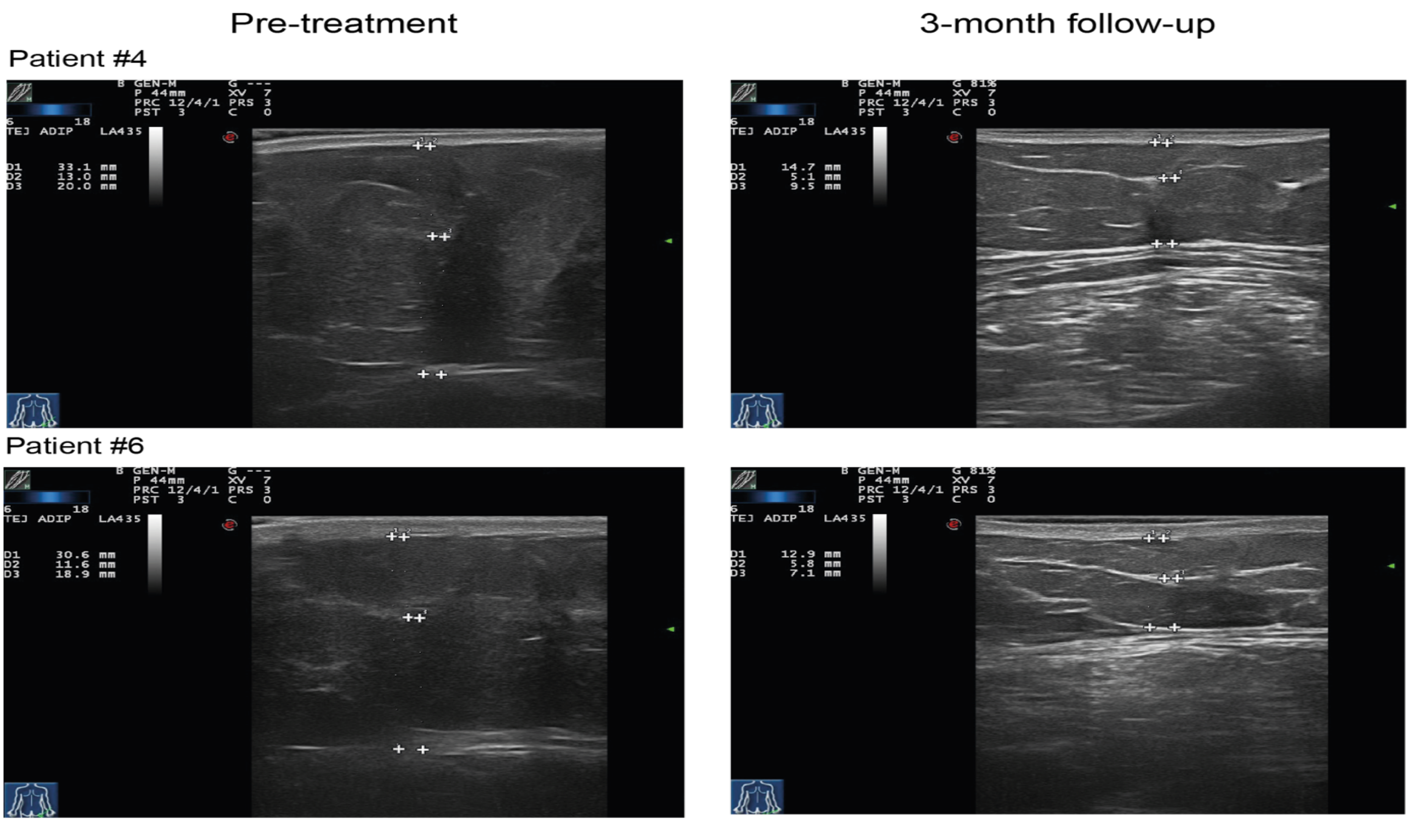

Figure 1: Example of fat layer measurements captured by echography with a 6-18 MHz linear probe (Mylab Class C, Esaote). Images of the area in each patient at baseline (left) and at the follow-up visit three months after the last treatment session (right). Crosses mark the Areolar and Lamellar fat layers.

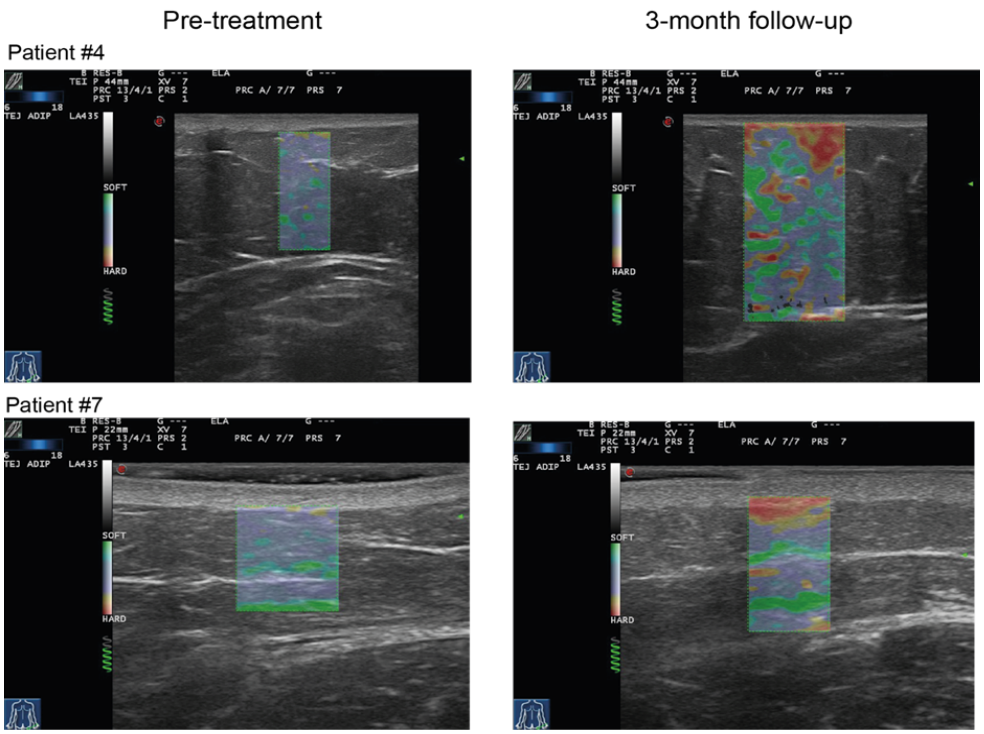

Figure 2: Examples of subcutaneous elasticity appearance captured by elastography with a 6-18 MHz linear probe. Images of the area in each patient at baseline (left) and at the follow-up visit three months after the last treatment session (right). Hardness scale from 1 (minimum) to 4 (maximum): 4 (red)/3 (orange)/2 (blue)/1 (green).

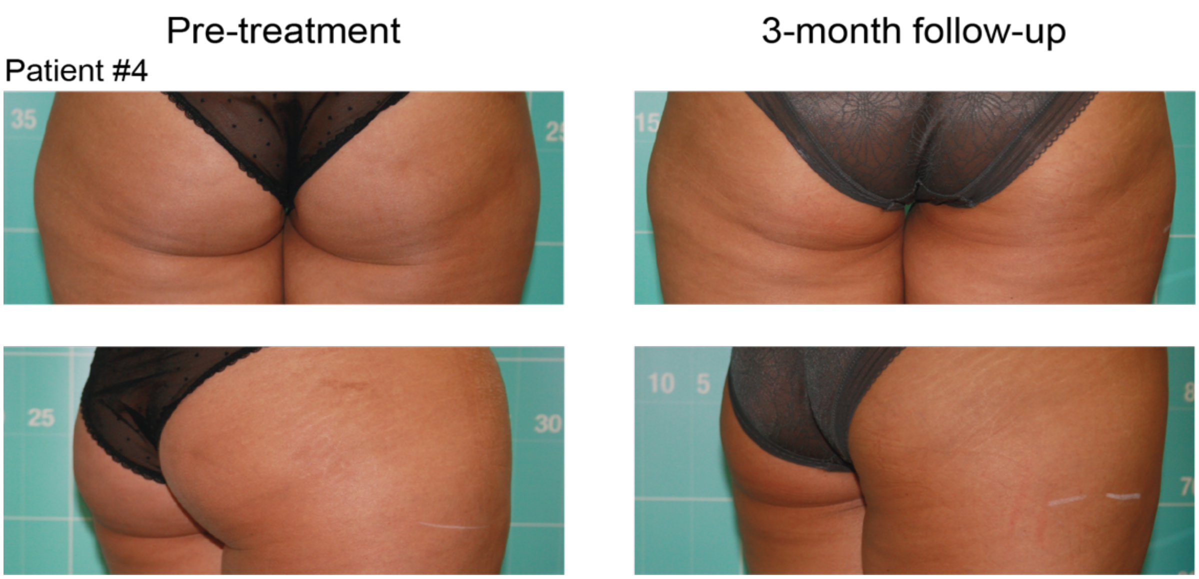

Figure 3: Patient photos of patient #4 pre-treatment (left) and at the follow-up visit three months after the last treatment session (right). This patient had a decrease of 56% in fat layer measurements and an increase of 50-75% in elasticity. She rated her patient satisfaction at 4 (out of 5).

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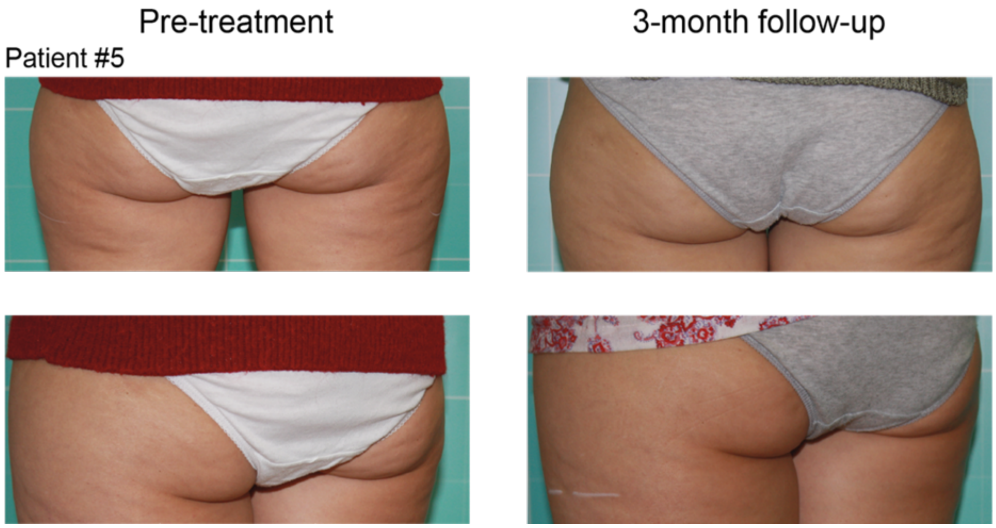

Figure 4: Patient photos of patient #5 pre-treatment (left) and at the follow-up visit three months after the last treatment session (right). This patient had a decrease of 43% in fat layer measurements and an increase of 50-75% in elasticity. She rated her patient satisfaction at 5 (out of 5).

Discussion

The demand, by patients, for minimally invasive procedures has increased substantially in the recent years. In 2020, 15.6 million cosmetic procedures were conducted in the United States alone, of which 13.2 were non-invasive [14]. This trend reflects a growing preference among patients for treatments that are effective while minimizing downtime and procedural risk. Correspondingly, the global market for non-invasive aesthetic treatments is estimated at ~$54 billion (B) [14]. The global buttock augmentation market is currently valued at $1.5B and is projected to grow to $11.2B by 2030. Current treatments are mainly surgical-based and involve using silicone implants, fat grafting (Brazilian butt lift), or combined techniques. According to the International Society of Aesthetic Plastic Surgery, approximately 644,770 buttock augmentation and lift procedures were performed globally in 2024, comprising 3.7% of the total surgical procedures globally [15]. High satisfaction rates of up to 95.6% have been reported for these interventions by the The American Society for Aesthetic Plastic Surgery. [14] however, they are associated with inherent surgical risks, prolonged recovery periods (up to 8 weeks), and potential complications such as implant displacement, asymmetry, and the need for revision procedures [14,16]. The reported rate of complications is relatively high and may reach 30.5% for gluteal augmentation with implants and 10.5% for autologous fat grafting [16].

These significant limitations highlight the need for safe and effective non-invasive alternatives for buttock contouring and augmentation. Ultrasound technology has been widely studied for adipose tissue reduction, showing a favorable safety profile when compared to liposuction and cryolipolysis [4,17,18]. An additional modality, radiofrequency (RF), provides a controlled thermal effect and heats the underlying adipose tissue, causing cell disruption and collagen remodeling, resulting in body shaping and tightening effects [7,8]. Emerging evidence suggests that treatment with ultrasound and RF modalities in the same session may provide synergistic effects, enhancing both fat reduction and skin tightening outcomes. Preliminary studies evaluating such treatments have demonstrated safety and efficacy in reducing abdominal fat, supporting the potential applicability of this approach to other anatomical areas [10]. The injection with Lenisna (Poly-D,L-lactic Acid+HA) had been descriebd as safe and effective in prior studies to strengthens facial ligaments inducing an lifting effect on overlying tissue [19]. In this study the combination of ultrasound, RF and Lenisna (Poly-D, L-lactic Acid+HA) injection improved elasticity of the buttocks area.

Conclusion

This proof-of-concept prospective case series of ten patients treated with ultrasound and RF preceded by dermal filler injection (PDLLA) and HA may offer a promising non-surgical approach for buttock augmentation. Quantitative analysis showed a 54%

reduction in fat layer thickness and a 55-67.5% improvement in elasticity at three months following treatment. Patient satisfaction was high (mean score 3.9/5), and no adverse events were recorded. Although longer follow-up and larger patients cohort are required, these findings suggest that this sequential new treatment may represent a safe and effective alternative to surgical buttock augmentation.

Conflict of Interest

The author is a consultant for Alma Lasers.

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