Clinical Investigation into the Application of Poly-L-Lactic Acid Microsphere Mesotherapy for Facial Rejuvenation: Observations on Improvements in Skin Tone, Texture, and Pores

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Abstract: Objective: To investigate the clinical efficacy of Poly-L-lactic acid (PLLA) microspheres administered via mesotherapy for facial rejuvenation, focusing on skin tone brightening, texture improvement, and pore size reduction, as well as its mechanisms and safety profile. Methods: A retrospective analysis was conducted on 40 patients who underwent facial PLLA microsphere mesotherapy at a tertiary class-A hospital between January 2025 and December 2025. All patients received multi-point, micro-droplet injections into the deep dermis. Quantitative assessments were performed using the VISIA skin analysis system (texture, pore count, brown spots) and Cutometer (skin elasticity, R2 parameter) at baseline and 3 months post-treatment. Adverse events were recorded. Results: At 3 months post-treatment, VISIA analysis showed significant reductions in pore scores (42.5 ± 5.6 to 28.3 ± 4.1, $P<0.001$) and texture scores (38.6 ± 4.8 to 25.1 ± 3.5, $P<0.001$). Cutometer results revealed increased skin elasticity R2 value (0.61 ± 0.08 to 0.72 ± 0.06, $P<0.001$). The overall patient satisfaction rate was 95%, with no nodules or granulomas observed. Conclusion: PLLA microsphere mesotherapy effectively induces dermal collagen regeneration, demonstrating significant clinical value in refining pores, brightening skin tone, and optimizing texture with a favorable safety profile. Combined with personalized injection protocols, it is an effective modality for comprehensive facial rejuvenation.

***Keywords*:** Poly-L-lactic acid (PLLA); microspheres; mesotherapy; facial rejuvenation; skin quality; collagen regeneration

1. Introduction

Facial aging involves multiple structural layers, characterized by deep skeletal support loss, fat volume reduction, and superficial skin quality decline (elastosis, enlarged pores, dullness, fine lines). Historically, facial rejuvenation relied on cross-linked hyaluronic acid (HA) for deep volume restoration [2], but this fails to address dermal extracellular matrix (ECM) aging.

In recent years, Poly-L-lactic acid (PLLA)—a biocompatible and biodegradable synthetic polymer—has evolved from a deep-tissue volumizer to a "Biostimulator" for skin quality management [1]. Initially used for absorbable sutures and orthopedic implants [11], PLLA's applications in soft tissue augmentation have expanded with U.S. FDA approval for HIV-associated facial lipoatrophy (2004), nasolabial fold correction (2009), and cheek fine lines (2023) [12][13]. Optimized microsphere morphology (reduced particle size, porous structure) enhances fibroblast stimulation for Type I and III collagen secretion [6], while advanced delivery techniques improve safety and efficacy.

Despite established deep-tissue injection efficacy, systematic data on PLLA mesotherapy for superficial skin quality improvement (e.g., "cocktail" techniques, ultrasound guidance) remains limited. This study retrospectively analyzes 40 clinical cases to quantify PLLA's efficacy in improving skin tone, texture, and pores.

2. Materials and Methods

2.1 General Data

Forty patients who underwent facial PLLA microsphere mesotherapy between January 2025 and December 2025 were selected. Detailed demographic characteristics are presented in Table 1.

2.1.1 Inclusion Criteria

(1) Age 25–55 years, with complaints of skin laxity, enlarged pores, or dull skin tone;

(2) Willingness to complete 3-month follow-up and non-invasive skin testing;

(3) No contraindications to PLLA injection (hypersensitivity, active cutaneous infections, keloid predisposition, pregnancy, immunosuppression) [8].

2.1.2 Exclusion Criteria

(1) Pregnancy or lactation;
(2) Facial photoelectric therapy or surgery within 6 months;
(3) Active skin infection, autoimmune diseases, or underlying vascular diseases (hypertension, diabetes) [14];
(4) Keloid formation history or PLLA component hypersensitivity.

Table 1. General characteristics of 40 patients

Item	Value/n
Gender	
Male	4 (10%)
Female	36 (90%)
Age (year, $\bar{x}\pm s$)	38.4 ± 4.2
Fitzpatrick Skin Type	
Type III	28 (70%)
Type IV	12 (30%)
Duration of Condition (year)	3.5 ± 1.2
Target Injection Areas	
Nasolabial region	40 (100%)
Lateral facial contours	35 (87.5%)
Temporal/malar region	29 (72.5%)
Neck	12 (30%)

2.2 Treatment Protocol

2.2.1 Preparation

An NMPA-approved injectable PLLA microsphere product (PuLiYan: Poly-L-lactic acid facial filler) with optimized particle size was used. PLLA lyophilized powder was reconstituted with sterile water for injection (7–8 mL total volume per vial) . The mixture was agitated using a vortex high-frequency oscillator to ensure uniform suspension.

2.2.2 Injection Technique

Injection strategies were individualized according to skin aging characteristics and anatomical requirements, rather than chronological age alone. Based on clinical assessment of skin texture, pore enlargement, dermal thickness, and soft tissue support, different injection approaches were adopted to optimize both efficacy and safety. Injection site: full face. The primary injection regions are illustrated in Figure 1.For patients presenting with early to moderate deterioration in skin texture and enlarged pores, predominantly involving the nasolabial and medial cheek regions (Figure 1), For patients presenting with early to moderate deterioration in skin texture and enlarged pores, predominantly involving the nasolabial and medial cheek regions (Figure 1), focused multi-point microinjections were performed using a 9-pin needle. Injections were delivered into the deep dermal layer at a depth of approximately 0.8–1.0 mm, with a volume of 0.03–0.05 mL per point, aiming to stimulate dermal collagen regeneration and improve skin quality.

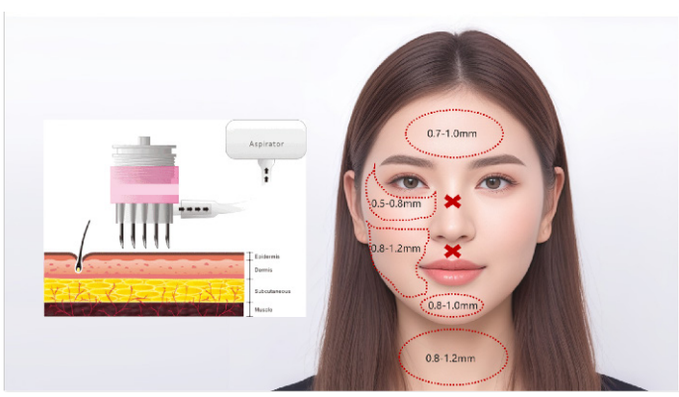

Figure 1. Hydrating Injection for Full Face + Neck

The total injection volume per session ranged from 4 to 8 mL, with dosage adjustments made according to the severity of skin quality impairment and the extent of treated areas.

2.3 Outcome Measures

Assessments were conducted at baseline and 3 months post-treatment:

(1) VISIA-CR Analysis: 400lux, 15cm distance imaging for "Pores," "Texture," "Brown Spots" (lower scores = better skin condition).

(2) Skin Elasticity: Cutometer MPA 580 probe (right cheek) for R2 parameter (Gross Elasticity; closer to 1 = superior elasticity).

(3) Safety and Satisfaction: Adverse event recording and Likert scale satisfaction evaluation.

(4) High-frequency Ultrasound: 20 MHz probe to monitor dermal remodeling and rule out subclinical nodules.

2.4 Statistical Analysis

SPSS 26.0 software was used. Normally distributed measurement data were expressed as mean ± standard deviation (). Pre- and post-treatment comparisons used paired t-tests. $P<0.05$ was considered statistically significant.

3. Results

3.1 Improvement in Skin Texture and Pores (VISIA)

At 3 months, patients' skin showed increased refinement and reduced roughness. VISIA analysis confirmed significant reductions in pore and texture scores (Table 2).

Table 2. Comparison of VISIA skin detection indexes before and after treatment (, score)

Group	n	Pores	Texture	Brown Spots
Before Treatment	40	42.5 ± 5.6	38.6 ± 4.8	35.2 ± 6.2
After 3 Months	40	28.3 ± 4.1	25.1 ± 3.5	30.8 ± 5.1
t-value	-	12.842	14.365	3.471
P-value	-	<0.001	<0.001	<0.05

Note: Compared with baseline, $P<0.05$, $P<0.001$

Pore and texture scores decreased by ~33.4% and 34.9%, respectively, surpassing the 12.5% brown spot reduction. VISIA imagery showed shallower follicular opening shadows in the nasal and medial cheek areas (Figure 2).

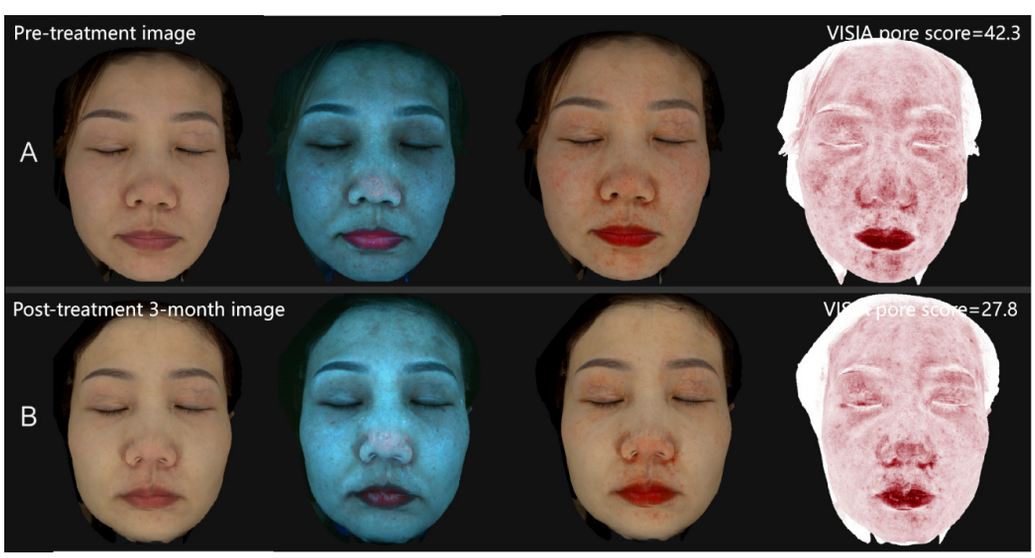

Figure 2. Representative VISIA images before and after treatment.

A: Pre-treatment image (nasolabial region) with deep pore shadows and rough texture (VISIA pore score = 42.3); B: Post-treatment 3-month image with reduced pore shadows and improved texture (VISIA pore score = 27.8). Note: Images were captured under identical conditions for comparability.

3.2 Changes in Skin Elasticity (Cutometer)

Cutometer results confirmed dermal collagen network remodeling. R2 value increased from 0.61 ± 0.08 to 0.72 ± 0.06 (18.03% improvement rate, $P<0.001$; Table 3), indicating enhanced skin recoil capacity and reduced hysteresis. Palpation

confirmed increased firmness and reduced laxity, consistent with Figure 1's anatomical targets.

Table 3. Comparison of skin elasticity R2 value before and after treatment ()

Time point	R2 Value	Improvement Rate
Before Treatment	0.61 ± 0.08	-
After 3 Months	0.72 ± 0.06	18.03%
t-value	6.945	-
P-value	<0.001	-

3.3 Patient Satisfaction and Safety Assessment

Overall patient satisfaction rate was 95% (65% "Very Satisfied," 30% "Satisfied," 5% "Neutral"). Subjective feedback included "better makeup adherence," "smoother cleansing feel," and "enhanced facial firmness."

All adverse reactions were transient (Table 4). High-frequency ultrasound confirmed no subclinical nodules or granulomas (Figure 3).

Table 4. Summary of adverse reactions after treatment (n=40)

Adverse Reactions	n	Incidence (%)	Duration	Management
Erythema	35	83.0%	24-48 h	Spontaneous resolution
Edema	28	66%	12-24 h	Cold compress relief
Ecchymosis	3	7.5%	5-7 days	Spontaneous absorption
Nodules	0	0.0%	-	-

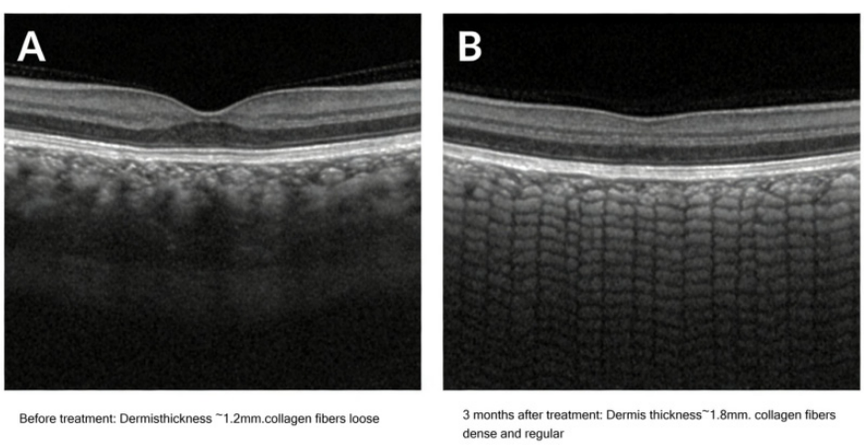

Figure 3. Representative high-frequency ultrasound images before and after treatment.

A: Pre-treatment image (20 MHz probe) showing 1.2mm dermal thickness and loose collagen fibers (high low-echo ratio); B: Post-treatment 3-month image showing 1.8mm dermal thickness and dense collagen fibers (high high-echo ratio). Note: Images were captured at the right malar region (avoiding vascular-rich areas) with 5mm detection depth.

4. Discussion

4.1 Biological Basis of Collagen Regeneration

PLLA's pore reduction and elasticity improvement mechanisms involve host immune responses [3]. In the present study, improvements in skin texture and pore refinement were more pronounced in regions with relatively preserved dermal thickness, such as the medial cheek and nasolabial area. This finding suggests that the collagen-stimulating effect of PLLA microspheres may be influenced by baseline dermal architecture, rather than acting uniformly across all facial regions[12].

PLLA microspheres adsorb macrophages in the dermis, recruiting fibroblasts for encapsulation. Porous PLLA microspheres accelerate collagen deposition and reduce nodule risk, forming a nascent collagen network that increases dermal thickness—supporting collapsed follicular openings ("tent effect") and enhancing skin biomechanical strength [5]. PLLA also improves dermal collagen synthesis by modulating M2 macrophage polarization in aged skin.

4.2 Mechanisms of Skin Brightening

Skin brightening (reduced VISIA Brown Spot scores) results from synergistic factors, It should be noted that, in this cohort, the degree of improvement in brown spot scores was less pronounced than that observed for pores and texture.From a clinical perspective, this suggests that PLLA microsphere mesotherapy primarily contributes to skin optical improvement through dermal remodeling, rather than directly targeting epidermal pigmentation[9].

increased dermal collagen density alters optical properties (reduced diffuse reflection, increased specular reflection), and PLLA-HA "cocktail" techniques enhance hydration and microcirculation, accelerating metabolic waste clearance[10].

4.3 Safety Optimization

Zero nodules in this study are attributed to:

(1) Porous, uniformly sized microspheres with uniform degradation .

(2) Precise deep dermal injection and ultrasound guidance in high-risk areas.

(3) Optimized dilution ratios for mesotherapy (7–8mL per vial) .

PLLA has lower migration and vascular occlusion rates than HA fillers, with transient erythema/edema resolving rapidly.

4.4 Study Limitations

This retrospective study lacks a placebo control group, and the 3-month follow-up only covers the first collagen regeneration peak. Future research should extend follow-up to 12–24 months, include diverse populations, and adopt randomized controlled designs. In addition, the author acknowledges that clinical outcome assessment was limited to standardized instruments, and subtle patient-perceived changes may not have been fully captured by objective measurements alone.

5. Conclusion

PLLA microsphere mesotherapy—enhanced by personalized injection protocols and optimized formulations—effectively improves skin tone, texture, and pore size via collagen regeneration. Its "zero nodules" safety record confirms deep dermal targeting, proper product preparation, and post-treatment care as key to balancing efficacy and safety. Aligning with the "regenerative anti-aging" trend, it provides clinicians with a safe, natural, and efficient facial rejuvenation solution. Future exploration of compounding techniques and personalized plans will further expand PLLA's potential in skin quality management.

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