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Original Article

Lower blepharoplasty plus periorbital collagen injection for lower eyelid skin laxity: efficacy, periorbital condition, and aesthetic impact

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Abstract: Objective: To evaluate the efficacy of lower blepharoplasty plus periorbital collagen injection in patients with lower eyelid skin laxity, as well as its effects on periorbital condition and aesthetics. Methods: We enrolled 199 patients with lower eyelid skin laxity treated at Guangzhou Yestar Medical Aesthetics Hospital between February 2022 and February 2025. Based on the treatment received, 95 patients were assigned to a control group (lower blepharoplasty alone) and 104 to a research group (lower blepharoplasty plus periorbital collagen injection). The following outcomes were assessed: curative efficacy; periorbital condition (skin radiance, crow's feet wrinkles, and infraorbital bags); canthal skin-related indices (wrinkle area, skin elasticity R2 value, skin firmness F4 value, and skin thickness); aesthetic effect; negative emotions (Self-Rating Anxiety Scale [SAS] and Self-Rating Depression Scale [SDS]); adverse reactions (lateral canthal incision scarring, incision redness/swelling, incisional discharge, lower eyelid ectropion, slight redness and swelling, and local pain); and patient satisfaction. Results: Compared to the control group, the research group showed markedly superior overall efficacy, significant post-treatment improvements in periorbital condition, canthal skin-related indices, aesthetic effect, and patient satisfaction, and milder negative emotions. The total adverse reaction rate did not differ significantly between the groups. Conclusion: Lower blepharoplasty plus periorbital collagen injection positively influenced curative efficacy, periorbital condition, and aesthetics in patients with lower eyelid skin laxity.

Keywords: Lower blepharoplasty, periorbital collagen injection, lower eyelid skin laxity, therapeutic effect, periorbital condition, aesthetics

Introduction

As the thinnest skin on the face, the periorbital skin, less than 1 mm thick, is prone to aging under the influence of sunlight, smoking, heredity, and other factors [1]. Over time, it also shows clinical signs of aging, manifested as increased supraorbital hollowing, wrinkles, softening and thinning of the upper and lower eyelid skin, and pigmentation, which are related to increased orbital septum relaxation, subcutaneous collagen loss, and orbital fat atrophy/prolapse [2]. Periorbital skin aging may also be related to age-related declines in fibroblast activity and to further reductions in skin firmness caused by extracellular matrix remodeling [3, 4]. Lower eyelid skin laxity is one of the common manifestations of periorbital skin aging, with its risk increasing with age and an incidence of 100% in 40-49-year-old individuals [5]. Because the early manifestations of periorbital aging are highly recognizable and modern people have strong demands for facial aesthetics, many patients seek effective intervention to ameliorate and delay the periorbital aging process [6]. Treatment options for lower eyelid skin laxity include surgery, laser, and fillers. Surgery, represented by lower blepharoplasty, can cause significant trauma to the eye area; laser therapy may lead to hyperpigmentation; and filler treatment requires regular maintenance and is therefore costly [7]. Reduced collagen synthesis is an important biological change during aging. Owing to its excellent tissue adhesion and low susceptibility to displacement, collagen helps improve pigmentation and structural dark circles and has been used as a restorative injection technique for perior-

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bital rejuvenation in Chinese patients [8, 9]. A study reported that non-crosslinked bovine collagen is safe and effective for softening wrinkles around the eyes [10]. It has also been reported that continuous 90-day intake of hydrolyzed collagen supplements helps slow skin aging, reduce wrinkles, and improve skin elasticity and moisture retention [11]. These studies have confirmed the effectiveness of collagen for facial rejuvenation; however, how collagen combined with lower blepharoplasty works for lower eyelid skin laxity has been insufficiently studied. Additional evidence on this combination may help optimize treatment selection for lower eyelid skin laxity.

Materials and methods

Case selection

Patients were eligible if they met the diagnostic criteria for periorbital skin laxity [12]; presented with relevant manifestations (e.g., deep crow's feet wrinkles around the eyes and dull skin); no intolerance or allergy to collagen; symptoms of decreased orbital septum elasticity and orbital fat prolapse; lower eyelid entropion with trichiasis or relaxation and hypertrophy of the orbicularis oculi muscle; normal communication and cognitive abilities; and complete clinical data. Exclusion criteria were cicatricial skin; pregnancy, lactation, or menstruation; heart, lung, or kidney dysfunction; a history of eye plastic surgery or recent intermediate or major surgery; concurrent malignant tumor; serious infectious disease, systemic inflammation, or coagulation dysfunction; allergic constitution; and contraindications to surgery or anesthesia. This retrospective study was approved by the Institutional Ethics Committee of Guangzhou Yestar Medical Aesthetics Hospital.

A total of 199 patients with lower eyelid skin laxity treated at Guangzhou Yestar Medical Aesthetics Hospital between February 2022 and February 2025 were enrolled after screening with the above criteria. Based on the treatment each patient actually received, 95 patients were assigned to a control group (lower blepharoplasty) and 104 to a research group (lower blepharoplasty plus periorbital collagen injection).

Assuming a significance level (α) of 0.05 and a power (1-β) of 0.80, 73 patients per group were required, which was increased to 86 per group after accounting for a 15% dropout rate. The actual enrollment of 95 control and 104 research patients met the minimum sample size requirements. The sample size was estimated using the following formula:

$$n = \frac{(Z_{1-\alpha/2}\sqrt{2\bar{p}(1-\bar{p})} + Z_{1-\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)})^2}{(p_1-p_2)^2}$$

Intervention methods

Lower blepharoplasty was performed in all patients as follows. A pulsed laser therapy device was used, with the laser beam energy set to ~300 mJ, the repetition frequency to 200 Hz, and the average output power to 60 W. In the supine position, the patient was routinely disinfected and draped, and 0.5% tetracaine was instilled for topical anesthesia. A metal pad was placed over the patient's lower eyelid, which was surgically everted to expose the lower palpebral conjunctiva. Infiltration anesthesia was performed in the conjunctiva and lower eyelid. The laser beam was aimed at a site 5 mm below the inferior border of the palpebral conjunctiva, followed by sequential incisions of the periorbital skin and orbicularis muscle. Along the incision, the orbital septum surface of the meibomian muscle and the deep surface of the orbicularis oculi muscle were peeled to a point 1 cm below the infraorbital margin using small straight ophthalmic scissors. During the operation, a transverse incision was made to fully expose the orbital septum. The traditional orbital septum suture method was used. Specifically, the patient was required to keep the eyes closed; the lower eyelid skin was spread upwards and the lower eyelid was pulled with an eyelid hook to expose the conjunctiva completely, allowing a small 1.5-cm curved incision to be made. On both sides of the surgical incision, traction sutures were placed using the traditional method, and then the tarsal muscle and palpebral fascia were separated from superior to inferior. After the orbital septum was cut with the laser beam, the muscle tissue flap above the edge of the eyelid incision was removed. Using toothed forceps, the tetracycline solution was applied to the flap and gently clamped. Blue marks

were drawn on the flap to precisely determine the location of the surgical incision. First, the fat was gently lifted and separated, then the excess part was cut off with the laser, and finally the traction suture was removed. After confirming the absence of bleeding, proper pressure dressing was applied, and the conjunctival incision was folded.

Patients in the research group additionally received periorbital injection of humanized type III collagen into the following sites: (1) for the tear trough, injection was performed at the periosteal layer using a 25G blunt needle, with the tear trough depression as the needle entry point, 0.5 mL per side and 1 mL in total; (2) for the upper eyelid, injection was performed at the deep dermis plane using a 27G blunt needle, with the upper eyelid depression near the bridge of the nose as the needle entry point, 0.5 mL per side, and 1 mL in total. Injections were given once every 2 weeks for a total of 2-3 sessions.

Data collection and outcome measures

Curative efficacy [10]: The following criteria were assessed at 1 month after treatment: marked effectiveness was defined as significant improvement in facial skin color, crow's feet wrinkles, and infraorbital bags; effectiveness as rosy facial skin color, smoothed crow's feet wrinkles, and reduced dark circles; and ineffectiveness as no improvement in facial skin color, crow's feet wrinkles, or infraorbital bags. The total effective rate was calculated as the number of markedly effective and effective cases divided by the total number of cases.

Periorbital condition: Skin radiance, crow's feet wrinkles, and infraorbital bags were evaluated before and 6 months after treatment. Skin radiance: skin gloss and moisture content were measured using a ViSiA 7 skin analyzer to assess skin health and glossiness. Crow's feet wrinkles: facial photographs were analyzed using the Canfield Scientific facial analysis software matched with the ViSiA 7 skin analyzer to accurately evaluate crow's feet wrinkles. Infraorbital bags: the severity of the bags was preliminarily assessed by observing the degree of facial skin laxity as well as the size, shape, and position of the bags. For accurate evaluation of bag shape and volume, optical coherence tomography was performed to examine the tissue structure and fat accumulation of the bags. Each item was scored from 0 to 20 before and 6 months after treatment, with higher scores indicating greater improvement. A ≥3-point increase from baseline in each item at 6 months after treatment was used as the threshold for skin radiance enhancement, crow's feet wrinkle smoothing, and infraorbital bag reduction.

Canthal skin-related indices: Using the ViSiA 7 skin analyzer, the wrinkle area, skin elasticity R2 value, skin firmness F4 value, and skin thickness were measured before and 6 months after treatment.

Aesthetic effect: A self-designed aesthetic score scale was used to evaluate the aesthetic effect based on incision scarring, binocular symmetry, tear trough, and lower eyelid skin wrinkles and glossiness. Each item was scored from 0 to 3 (0 = poor, 1 = fair, 2 = good, 3 = excellent), with higher scores indicating better aesthetic effects.

Negative emotions: Patients were assessed using the Self-rating Anxiety (SAS) and Depression Scale (SDS). Each scale contains 20 items. The raw score was calculated by summing all item scores and multiplying by 1.25 to obtain the standardized total score (range, 25-100). Higher scores indicate more severe anxiety and depression.

Adverse reactions: The numbers and percentages of patients who experienced lateral canthal incision scarring, incision redness/swelling, incisional discharge, lower eyelid ectropion, slight redness and swelling, or local pain were observed and recorded.

Patient satisfaction: Satisfaction was assessed using a 100-point questionnaire developed by our hospital (0-59, dissatisfied; 60-80, moderately satisfied; ≥81, very satisfied). The satisfaction rate was calculated as (very satisfied + moderately satisfied cases)/total cases × 100%.

Follow-up: Patients were followed up through re-examinations at 1 and 6 months after treatment.

Statistical methods

Shapiro-Wilk test (for normality) and Levene's test (for homogeneity of variance) were performed on all measured data before analysis.

Table 1. Baseline patient data

Indicator	Control group (n=95)	Research group (n=104)	χ^2/t	P
Age (years)	49.59±5.49	50.23±7.62	0.674	0.501
Sex			0.486	0.486
Male	26 (27.37)	24 (23.08)		
Female	69 (72.63)	80 (76.92)		
Weight (kg)	65.61±6.55	66.87±8.14	1.196	0.233
Height (cm)	165.16±5.94	163.80±6.77	1.500	0.135
Education level			2.321	0.677
Primary school	10 (10.53)	6 (5.77)		
Junior high school	22 (23.16)	25 (24.04)		
Senior high school	28 (29.47)	27 (25.96)		
Junior college	20 (21.05)	27 (25.96)		
Bachelor degree or above	15 (15.79)	19 (18.27)		
Hodge classification			2.827	0.419
I	8 (8.42)	10 (9.62)		
II	24 (25.26)	21 (20.19)		
III	38 (40.00)	35 (33.65)		
IV	25 (26.32)	38 (36.54)		
Fitzpatrick grading			1.291	0.524
Grade 1	22 (23.16)	18 (17.31)		
Grade 2	41 (43.16)	45 (43.27)		
Grade 3	32 (33.68)	41 (39.42)		
Smoking history			0.435	0.509
No	75 (78.95)	78 (75.00)		
Yes	20 (21.05)	26 (25.00)		
Diabetes history			0.621	0.431
No	88 (92.63)	93 (89.42)		
Yes	7 (7.37)	11 (10.58)		

If the data followed a Gaussian distribution and had equal variances, they were presented as mean ± standard deviation (SD), and inter- and within-group comparisons were conducted using the independent samples t-test and paired t-test, respectively. If the data were non-normally distributed or had unequal variances, they were presented as median (interquartile range) and compared using the Mann-Whitney U test (between groups) and the Wilcoxon signed rank test (within groups). Categorical data were presented as rates (percentages) and compared between groups using the χ^2 test. All analyses were performed using SPSS 22.0, and P<0.05 was considered significant.

Results

Baseline data analysis

There were no significant differences between the two groups in age, sex, weight, height, education level, Hodge classification, Fitzpatrick grading, smoking history, or diabetes history (all P>0.05; **Table 1**).

Analysis of curative efficacy

In the control group, 33, 38, and 24 cases were rated as markedly effective, effective, and ineffective, respectively; the corresponding numbers in the research group were 52, 43, and 9. The total effective rate was significantly higher in the research group than in the control group (91.35% *vs.* 74.74%, P=0.002; **Table 2**).

Assessment of periorbital condition

The two groups had comparable baseline scores for skin radiance, crow's feet wrinkles, and infraorbital bags (all P>0.05). After treatment, the scores of both groups increased sig-

Table 2. Curative efficacy

Indicator	Control group (n=95)	Research group (n=104)	χ^2	P
Marked effectiveness	33 (34.74)	52 (50.00)		
Effectiveness	38 (40.00)	43 (41.35)		
Ineffectiveness	24 (25.26)	9 (8.65)		
Total	71 (74.74)	95 (91.35)	9.901	0.002

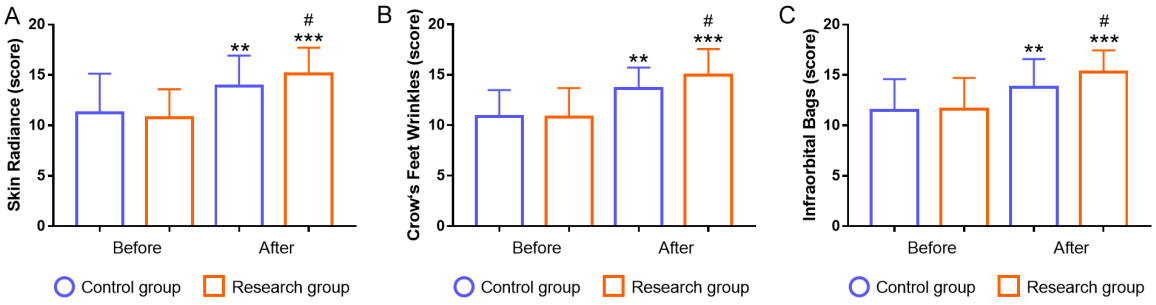


Figure 1. Periorbital conditions. A. Skin radiance scores before and after treatment. B. Crow's feet scores before and after treatment. C. Infraorbital bag scores before and after treatment. Note: **P<0.01, ***P<0.001 *vs.* pre-treatment; $^{\#}$P<0.05 *vs.* control group.

Table 3. Periorbital condition improvement

Indicator	Control group (n=95)	Research group (n=104)	χ^2	P
Skin radiance enhancement	47 (49.47)	74 (71.15)	9.792	0.002
Crow's feet wrinkle smoothing	50 (52.63)	77 (74.04)	9.853	0.002
Infraorbital bag reduction	46 (48.42)	65 (62.50)	3.990	0.046

nificantly (all P<0.05), and the increase was more pronounced in the research group (all P<0.05; **Figure 1**).

A ≥3-point improvement from baseline in skin radiance, crow's feet wrinkle, and infraorbital bag scores was considered clinically significant. The research group showed significantly higher rates of skin radiance enhancement, crow's feet wrinkle smoothing, and infraorbital bag reduction than the control group (all P<0.05; **Table 3**).

Evaluation of canthal skin-related indices

Baseline wrinkle area, skin elasticity R2 value, skin firmness F4 value, and skin thickness did not differ significantly between the groups (all P>0.05). After treatment, both groups showed a significant reduction in wrinkle area and skin firmness F4 value and a significant increase in skin elasticity R2 value and skin thickness (all P<0.05). Compared to the control group, the research group had a lower wrinkle area and skin firmness F4 value and a higher skin elasticity R2 value and skin thickness (all P<0.05; **Figure 2**).

Aesthetic effect assessment

The two groups did not differ significantly in pre-treatment aesthetic effect scores (P>0.05). Both groups showed a significant increase in aesthetic effect score after treatment, with a higher score in the research group than in the control group (P<0.001; **Table 4**).

Analysis of negative emotions

Baseline SDS and SAS scores were comparable between the two groups (both P>0.05). The two groups showed significant post-treatment reductions in both scale scores, and the scores were lower in the research group than in the control group (both P<0.001; **Table 5**).

Evaluation of adverse reactions

The total number of adverse reactions was 17 in the control group and 18 in the research

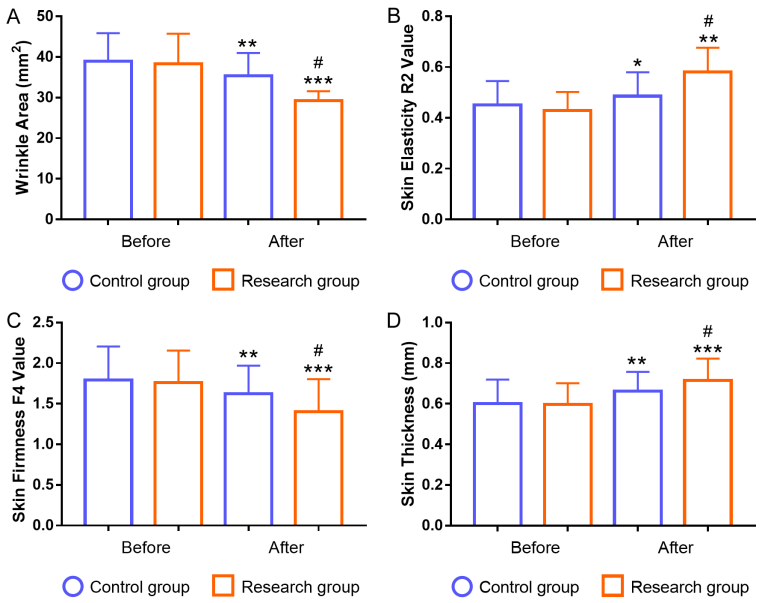


Figure 2. Canthal skin-related indices. A. Wrinkle area before and after treatment. B. Skin elasticity R2 value before and after treatment. C. Skin firmness F4 value before and after treatment. D. Skin thickness before and after treatment. Note: *P<0.05, **P<0.01, ***P<0.001 vs. pre-treatment; #P<0.05 vs. control group.

group, with no significant between-group difference in the overall incidence (P>0.05). The adverse reactions in both groups were mild and transient. Specifically, lateral canthal incision scarring required no special treatment and resolved spontaneously within 6 months after surgery, without an obvious line or demarcation. Incision redness/swelling was alleviated by ice compress and basically subsided within 1 month after surgery. Patients with incisional discharge were treated by applying a thin layer of Mupirocin Ointment 1-2 times a day after cleaning and disinfecting the area with sterile normal saline, and the discharge stopped within 7 days after surgery. All patients with lower eyelid ectropion recovered spontaneously within 2-3 months after surgery. Slight redness and swelling were relieved by ice application and resolved within 24-48 hours after injection. Local pain was relieved by ice application and disappeared within 7 days after surgery (**Table 6**).

Patient satisfaction analysis

The overall satisfaction rate was 77.89% in the control group and 94.23% in the research group (P<0.001; **Table 7**).

Discussion

Our study first found that lower blepharoplasty plus periorbital collagen injection further improved curative efficacy, increasing the total effective rate from 74.74% with lower blepharoplasty alone to 91.35% with the combination. By using a laser to accurately cut, dissect, and remove sagging skin and excess orbital septum fat, and by employing orbital septum suture and pressure dressing to reconstruct the supporting structure of the lower eyelid tissue, lower blepharoplasty mechanically eliminates infraorbital bags and improves skin firmness [13, 14]. Volume augmentation and mechanical support from periorbital injection of humanized type III collagen into the tear trough periosteal layer and the upper eyelid deep dermis replenish aging-related tissue loss and stimulate autologous collagen regeneration, thereby restoring orbital fat structure and enhancing skin elasticity and firmness. The combined use of the two procedures can further enhance the curative efficacy for lower eyelid skin laxity. As reported by Sun et al. [15], recombinant humanized type III collagen injection can also be used to treat chloasma: by decreasing the melanin index and increasing stratum corneum hydration, it improves elastic fiber arrangement and reduces elastin nodule density, thereby achieving clinical effectiveness. Another *in vitro* and *in vivo* study reported that humanized type III collagen mRNA effectively inhibited oxidative stress, aging, and apoptosis in cellular photoaging models; in a murine photoaging model, it also improved skin barrier function, increased dermal thickness, restored collagen content, and inhibited cell senescence markers, without causing systemic toxicity or immunogenicity [16]. These findings may partly explain the clinical effectiveness and safety of periorbital collagen injection for lower eyelid skin laxity.

Second, the combined intervention significantly improved periorbital condition, including

Table 4. Aesthetic effect

Indicator	Control group (n=95)	Research group (n=104)	Z	P
Pre-treatment	6.00 (4.00, 8.00)	6.50 (5.00, 8.00)	-1.115	0.265
Post-treatment	10.00 (8.00, 11.00)	11.00 (10.00, 13.00)	-4.192	<0.001

Table 5. Negative emotions

Indicator	Control group (n=95)	Research group (n=104)	t	P
SDS (points)				
Pre-treatment	56.46±6.13	55.95±7.99	0.498	0.619
Post-treatment	48.33±6.05	39.86±5.04	10.643	<0.001
SAS (points)				
Pre-treatment	53.85±7.06	55.22±7.13	1.348	0.179
Post-treatment	44.13±7.56	34.77±5.51	9.916	<0.001

Note: SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale.

Table 6. Adverse reactions

Indicator	Control group (n=95)	Research group (n=104)	χ^2	P
Lateral canthal incision scarring	6 (6.32)	4 (3.85)		
Incision redness/swelling	4 (4.21)	3 (2.88)		
Incisional discharge	5 (5.26)	3 (2.88)		
Lower eyelid ectropion	2 (2.11)	1 (0.96)		
Slight redness and swelling	0 (0.00)	4 (3.85)		
Local pain	0 (0.00)	3 (2.88)		
Total	17 (17.89)	18 (17.31)	0.012	0.914

Table 7. Patient satisfaction

Indicator	Control group (n=95)	Research group (n=104)	χ^2	P
Very satisfied	36 (37.89)	62 (59.62)		
Moderately satisfied	38 (40.00)	36 (34.62)		
Dissatisfied	21 (22.11)	6 (5.77)		
Overall satisfaction	74 (77.89)	98 (94.23)	11.298	<0.001

skin radiance, crow's feet wrinkles, and infraorbital bags. This may be because the combination more effectively reduced periorbital skin laxity, thereby significantly reducing wrinkles and enhancing skin elasticity, firmness, and thickness. Wu et al. [17] applied a three-step collagen injection technique in patients with eye aging. At the 3-6-month follow-up, dark circles, tear trough, and superficial fine lines were significantly improved, skin barrier thickness was increased, and skin physiologic state was improved, with good cosmetic effects, patient acceptance, and reliable clinical safety; these findings are consistent with our results. Chen et al. [18] reported that recombinant type I & III chimeric collagen promoted the proliferation, migration, and adhesion of fibroblasts and the production of endogenous type I & III collagen, thereby effectively softening wrinkles and crow's feet around the eyes and slowing periorbital aging without inducing side effects, which may provide a novel, effective, and safe treatment option for patients with lower eyelid skin laxity. This may be related to the finding that recombinant humanized collagen, by up-regulating COL1A1 expression through activation of the TGF-β/Smad3 axis, promotes fibroblast proliferation, adhesion, and migration, which increases dermal thickness, restores collagen content, and improves dermal structure, thereby effectively reducing wrinkles and improving skin elasticity, firmness, and thickness [19].

Regarding aesthetics, the addition of periorbital collagen injection to lower blepharoplasty enhanced the aesthetic effect. Regarding negative emotions, the combination contributed to greater relief of anxiety and depression. This may be explained by the synergy between lower blepharoplasty and periorbital collagen injection, which work together to enhance periorbital rejuvenation; the significantly rejuvenated periorbital and canthal skin likely improved the aesthetic effect score and alleviated anxiety and depression in patients with periorbital aging. Safety statistics indicated that the combination did not significantly increase the total adverse reaction rate. Finally, lower blepharoplasty plus periorbital collagen injection further increased overall patient satisfaction. Tao et al. [20] reported that recombinant humanized type III collagen injection significantly improved skin quality, tone, and luster, effectively reduced wrinkles and pore size, and increased skin thickness, density, elasticity, and firmness in Chinese patients with photoaging, which is similar to the results of this study.

This study had several limitations. First, because all 199 patients were enrolled from a single center, the sample may not have been sufficiently representative; future multicenter studies with broader sampling are needed to improve representativeness. Second, the underlying mechanism of periorbital collagen injection was not explored, and further basic experiments are needed to investigate the potential molecular mechanisms. Third, the economic benefits of the two treatments were not evaluated; collecting relevant data in future prospective studies may facilitate the clinical application of the combined therapy.

In conclusion, lower blepharoplasty plus periorbital collagen injection was clinically superior to lower blepharoplasty alone for lower eyelid skin laxity. The combination further improved curative efficacy, periorbital and canthal conditions, aesthetic effects, and patient satisfaction, and relieves negative emotions, without significantly increasing the overall adverse reaction rate. This study confirmed, for the first time, the clinical effectiveness and safety of lower blepharoplasty plus periorbital collagen injection for lower eyelid skin laxity, providing a more effective treatment approach for these patients.

Disclosure of conflict of interest

None.

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