Article

Correlation and Responsiveness of Objective and Subjective Measures in Evaluating Periorbital Swelling After Upper Blepharoplasty: A Retrospective Study Using 3D Stereophotography and Visual Analogue Scale

Ann. Ital. Chir., 2026: 1–8
https://doi.org/10.62713/aic.4527

Chang Ge[1], Chen Ge[2], Yufei Zhang[1], Kaixin Yang[1], Ke Li[1], Jinlong Huang[1]

[1]Department of Plastic Surgery, Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine, 210029 Nanjing, Jiangsu, China
[2]Department of Burns and Plastic Surgery, Affiliated Hospital of Jiangnan University, 214122 Wuxi, Jiangsu, China

AIM: To compare the correlation between three-dimensional stereophotography (3D-SPG) and visual analogue scale (VAS) in the evaluation of periorbital swelling after upper blepharoplasty, and to provide a basis for postoperative swelling monitoring and recovery evaluation.
METHODS: This retrospective study included 39 patients who underwent upper blepharoplasty between December 2024 and April 2025. On postoperative days 1, 7, 14, and 28, 3D-SPG was used to measure objective morphological volume and double-eyelid fold width, while periorbital swelling experienced by the patients was assessed using a visual analogue scale. Changes in objective morphological volume and VAS scores from their baseline levels were calculated. Repeated measures analysis of variance was used to assess changes over time, and Pearson correlation analysis was used to evaluate the correlation between objective morphological volume and VAS scores. Standardized response mean (SRM) was calculated to compare the responsiveness of the two parameters.
RESULTS: During the postoperative 28-day period, the double-eyelid fold width, VAS score, and objective morphological volume decreased significantly over time (all $p < 0.001$). There was a significant positive correlation between the objective morphological volume and VAS score in the early postoperative period (d1–d7) (left eye: d1 r = 0.467, p = 0.003; d7 r = 0.546, $p < 0.001$; right eye: d1 r = 0.449, p = 0.004; d7 r = 0.497, p = 0.001). At late postoperative days (d14–d28), the correlation weakened and became not statistically significant (left eye: d14 r = 0.098, p = 0.555; d28 r = 0.175, p = 0.286; right eye: d14 r = 0.254, p = 0.119; d28 r = 0.113, p = 0.494). Sensitivity analysis showed that both parameters demonstrated high responsiveness in the early intervals (d1–d7 and d7–d14). However, 3D-SPG maintained consistently higher responsiveness throughout the observation period (SRM = 3.406–5.007), whereas VAS showed a decline in responsiveness in the late interval (d14–d28), potentially due to a floor effect (SRM = 0.902–1.355).
CONCLUSIONS: Both 3D-SPG and VAS demonstrate distinct performance characteristics across postoperative stages. 3D-SPG provides objective, quantitative volumetric data, while VAS captures patient-perceived symptoms. These findings suggest that both methods assess different dimensions of postoperative swelling. However, further studies are needed to determine whether their combined use offers additional clinical benefit.

Keywords: upper blepharoplasty; three-dimensional stereophotography; visual analogue scale; postoperative swelling

Introduction

Upper and lower blepharoplasty are widely performed surgical procedures to address periorbital skin laxity and/or orbital septal fat deposition. Although the surgical trauma associated with blepharoplasty is mainly limited to the ocular region, prolonged periorbital soft tissue edema and stasis after surgery can prolong the recovery period and hamper accurate evaluation of the surgical outcomes [1]. Therefore, precise assessment of the extent and duration of postoperative swelling can enhance patient satisfaction with surgical outcomes and guide clinicians in implementing targeted intervention strategies.

At present, the commonly used clinical methods for evaluating ocular changes after blepharoplasty include direct physical measurement, evaluation based on two-dimensional (2D) planar images, and three-dimensional (3D) imaging techniques, such as three-dimensional stereophotography (3D-SPG). Direct physical measurement requires tools such as calipers, tape measures, and a protractor. However, this method is less precise and prone to measurement errors, and the manual pressure applied to the ocular tissues during assessment may alter local tissue volume and introduce bias. Postoperative evaluation based on 2D images benefits from increasingly standardized imaging protocols, which enable rapid and efficient

Submitted: 6 January 2026 Revised: 16 March 2026 Accepted: 26 March 2026 Published: 27 May 2026
Correspondence to: Jinlong Huang, Department of Plastic Surgery, Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine, 210029 Nanjing, China (e-mail: drhuangjl@163.com).
Editor: Zoia Cesare

acquisition of images for preoperative planning and postoperative follow-up evaluations. However, due to the lack of a unified measurement gold standard, the accuracy of 2D imaging remains controversial. By nature, 2D photogrammetry lacks 3D spatial information and cannot reliably quantify periocular volumetric changes before and after surgery, resulting in discrepancies between measured values and actual anatomical conditions. In addition, 2D facial imaging is susceptible to confounding factors such as lighting conditions, changes in patient posture, shooting distance, and equipment parameters [2].

By using 3D-SPG, various forms of 3D facial morphological data, such as soft tissue surface color, texture, and spatial metrics, can be captured [3–5]. This technique accurately reconstructs the surface topography of soft tissue and is well-suited for volumetric analysis. It is worth noting that the measurement error of the stereophotography devices has been reported to be less than 1 mm compared with the direct measurement methods [3]. A comparative study evaluating direct measurement, 2D and 3D techniques for periocular assessment demonstrated that 3D stereophotography offers excellent reliability [6]. Three-dimensional surface imaging technology is now widely used in plastic and aesthetic surgery, providing objective and reliable reference data for evaluating outcomes of procedures such as facial filler injections and radiofrequency microneedle surgery [7,8]. In addition to objective measurements, subjective evaluations of postoperative swelling, such as self-rated visual analogue scale (VAS), are widely used in clinical practice. However, patient perception does not always align with objective morphological volume changes, which may lead to discrepancies in postoperative evaluation. Moreover, only a study has applied 3D-SPG to assess volumetric changes following blepharoplasty [9], and few have compared its correlation and responsiveness with subjective measures such as VAS in the assessment of postoperative periorbital swelling. Therefore, this retrospective study aimed to compare the correlation and responsiveness of 3D-SPG and VAS in evaluating periorbital swelling after upper blepharoplasty, thereby providing a basis for postoperative monitoring and recovery evaluation.

Methods

Study Design

This study was approved by the Ethics Committee of Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine (approval number: 2025NL-064-02) and conducted in accordance with the Declaration of Helsinki. Clinical records of patients who underwent upper blepharoplasty at the Plastic Surgery Outpatient Clinic of Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine from December 2024 to April 2025 were included. Inclusion criteria were as follows: (1) age $>$18 years; (2) no prior history of ocular plastic surgery; and (3) completion of one-month postoperative follow-up. Exclusion criteria were as follows: (1) medical history of facial pathologies, deformations, or impairment; and (2) history of surgeries that may affect facial morphology. After a careful subject selection based on the pre-defined inclusion and exclusion criteria, a total of 39 patients were enrolled, including 32 females and 7 males. All patients underwent 3D-SPG to quantify the objective morphological volume of the upper eyelid and double-eyelid fold width, while periorbital swelling was assessed using the VAS.

Ocular Volumetric Assessment Using 3D-SPG

The 3D LifeViz Micro stereoscopic photography system (QuantifiCare) was used in combination with Dermapix software (version 3.0, QuantifiCare) [10] for 3D visualization and quantitative measurement of the objective morphological volume [11–14]. Patients were assessed preoperatively and on postoperative days 1, 7, 14, and 28. To ensure reproducibility, patient positioning was standardized using floor markings, and 3D images were captured using the 3D LifeViz Micro stereoscopic photography system with the eyes closed and a neutral facial expression [14].

The upper eyelid region was defined using consistent anatomical landmarks: the inferior boundary was the closed palpebral fissure line; the superior boundary followed the curve along the inferior margin of the eyebrow arch corresponding to the supraorbital rim; and the medial and lateral boundaries were defined by vertical extensions from the inner and outer canthi [15]. Volume computation was performed by automatically replicating electronic landmarks on registered 3D models across time points, with objective morphological volume derived using a surface-based subtraction method between aligned postoperative and preoperative models. Standard 2D clinical photographs were obtained at each follow-up visit for clinical documentation or auxiliary positioning [16]. The change in immediate double-eyelid fold width was calculated as the immediate double-eyelid fold width minus the width of the preoperatively double-eyelid line.

VAS Assessment

Patients self-rated the degree of eyelid and periorbital edema using a VAS. The assessment tool consisted of a 10-cm horizontal line, with “0 (no swelling)” at the left end and “100 (severe swelling)” at the right end. Patients marked the point on the line corresponding to their perceived swelling intensity. The distance between the marked point and the left end (accurate to millimeters) was measured by the investigator and converted to a 0–100 score as the VAS edema value at each time point [17]. Using the preoperative measurement as baseline, changes in VAS scores were calculated for each postoperative time point (d1, d7, d14, d28).

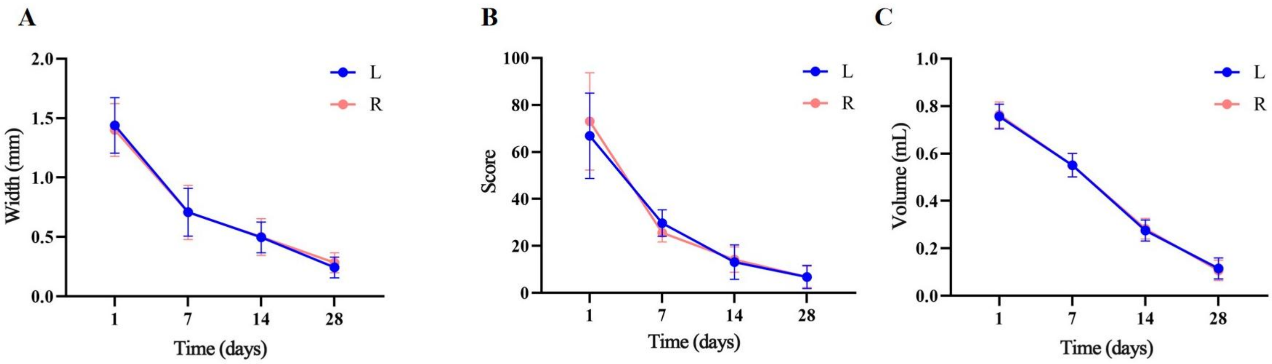

Fig. 1. Postoperative temporal changes in double-eyelid fold width, VAS scores, and objective morphological volume. (A) Double-eyelid fold width. (B) VAS scores. (C) Objective morphological volume. VAS, visual analogue scale; L, left; R, right.

Table 1. Temporal changes in double-eyelid fold width, VAS scores, and objective morphological volume (repeated measures ANOVA).

		Double-eyelid fold width			VAS scores			Objective morphological volume		
Position	Time (days)	Mean ± SD (mm)	F	*p*	Mean ± SD (points)	F	*p*	Mean ± SD (mL)	F	*p*
Left eyelid	d1	1.439 ± 0.232	438.966	<0.001	66.872 ± 18.160	330.488	<0.001	0.756 ± 0.052	1556.334	<0.001
	d7	0.708 ± 0.200			29.744 ± 5.628			0.551 ± 0.049		
	d14	0.497 ± 0.129			13.103 ± 7.351			0.275 ± 0.044		
	d28	0.243 ± 0.088			6.769 ± 4.928			0.115 ± 0.044		
Right eyelid	d1	1.401 ± 0.222	413.197	<0.001	73.000 ± 20.714	324.737	<0.001	0.763 ± 0.055	1484.894	<0.001
	d7	0.707 ± 0.228			25.641 ± 3.930			0.551 ± 0.049		
	d14	0.500 ± 0.154			14.205 ± 5.401			0.283 ± 0.043		
	d28	0.284 ± 0.085			6.821 ± 4.547			0.107 ± 0.042		

VAS, visual analogue scale; ANOVA, analysis of variance.

Statistical Analysis

The collected data were exported to Microsoft Excel (version 16.0, Microsoft Corporation) and analyzed using SPSS (version 26, IBM Corporation). Normality was assessed using the Shapiro–Wilk test, and the results showed that all variables were normally distributed. Repeated measures analysis of variance (ANOVA) was used to analyze the temporal changes in objective morphological volume, VAS scores, and double-eyelid fold width, with sphericity assessed using Mauchly's test. Greenhouse–Geisser correction was applied if sphericity was not satisfied, and Bonferroni post-hoc comparisons were performed if necessary. Pearson correlation analysis was used to compare the correlation between objective morphological volume measurements and VAS scores at each time point, and the correlation coefficients were calculated at each time point. Responsiveness across the intervals d1–d7, d7–d14, and d14–d28 was evaluated using the standardized response mean (SRM).

Results

Baseline Characteristics of Patients

A total of 39 patients who underwent upper blepharoplasty from December 2024 to April 2025 were included in this study, including 32 females and 7 males. The mean age of the patients was 24.6 ± 5.3 years, and the mean BMI was 23.2 ± 3.3 kg/m^2. All patients underwent bilateral incisional upper blepharoplasty and presented with no preoperative periorbital edema. The mean operative time was 110.7 ± 37.4 minutes. The degree of upper eyelid skin laxity was classified as none in 12 patients, mild in 15, moderate in 10, and severe in 2.

Trend of Postoperative Swelling Recovery

The immediate double-eyelid fold width showed a significant downward trend over the postoperative recovery time, with similar patterns observed in both eyes. The left eyelid fold width decreased from 1.439 ± 0.232 mm on day 1 to 0.243 ± 0.088 mm on day 28, while the right eyelid fold width decreased from 1.401 ± 0.222 mm on day 1 to 0.284 ± 0.085 mm on day 28. Repeated measures ANOVA showed that time had a significant effect on the width of both eyes (left eyes: F = 438.966, $p < 0.001$; right eyes: F = 413.197, $p < 0.001$) (Table 1, Fig. 1).

The subjective VAS score for swelling showed a significant downward trend over the postoperative recovery period ($p < 0.001$), with similar patterns observed in both eyes. The left eye VAS score decreased from 66.872 ± 18.160 points

Table 2. Pearson correlation between objective morphological volume and VAS scores at different postoperative time points.

Position	Time (days)	r	*p*
Left eyelid	d1	0.467	0.003
	d7	0.546	<0.001
	d14	0.098	0.555
	d28	0.175	0.286
Right eyelid	d1	0.449	0.004
	d7	0.497	0.001
	d14	0.254	0.119
	d28	0.113	0.494

Table 3. Responsiveness analysis of objective morphological volume and VAS scores.

Position	Time (days)	Objective morphological volume	VAS score
Left eyelid	d1–d7	5.007	2.782
	d7–d14	3.528	1.974
	d14–d28	3.788	0.902
Right eyelid	d1–d7	3.406	2.452
	d7–d14	3.821	2.067
	d14–d28	4.437	1.355

on day 1 to 6.769 ± 4.928 points on day 28, while the right eye score decreased from 73.000 ± 20.714 on day 1 to 6.821 ± 4.547 on day 28. Repeated measures ANOVA demonstrated a significant effect of time on VAS scores in both eyes (left eye: F = 330.488, $p < 0.001$; right eye: F = 324.737, $p < 0.001$) (Table 1, Fig. 1).

The objective morphological volume of the upper eyelid demonstrated a significant decreasing trend over time after surgery, and the pattern of changes was similar in both left and right eyes. The left eyelid volume decreased from 0.756 ± 0.052 mL on day 1 to 0.115 ± 0.044 mL on day 28, while the right eyelid volume decreased from 0.763 ± 0.055 mL to 0.107 ± 0.042 mL over the same period. Repeated measures ANOVA showed that the time factor had a significant effect on the volumetric changes in both eyes (left eye: F = 1556.334, $p < 0.001$; right eye: F = 1484.894, $p < 0.001$).

Overall, changes in the objective morphological volume measurements, the perceived measurements using VAS score, and double-eyelid fold width demonstrated a consistent temporal trend, all indicating a gradual resolution of postoperative edema over time (Table 1, Fig. 1).

Correlation Analysis

In this study, Pearson correlation analysis was used to evaluate the correlation between objective morphological volume and VAS score at different time points after surgery (d1, d7, d14, d28). The correlation showed a dynamic pattern over time. In the early postoperative period (d1 and d7), a significant positive correlation was observed for both eyes: left eye (d1: r = 0.467, $p = 0.003$; d7: r = 0.546, $p < 0.001$) and right eye (d1: r = 0.449, $p = 0.004$; d7: r = 0.497, $p = 0.001$). However, at later time points (d14 and d28), the correlation weakened and became not statistically significant for either eye (left eye: d14 r = 0.098, $p = 0.555$; d28 r = 0.175, $p = 0.286$; right eye: d14 r = 0.254, $p = 0.119$; d28 r = 0.113, $p = 0.494$). These findings suggest that different evaluation methods may be more appropriate at different stages of postoperative recovery (Table 2).

Sensitivity Analysis of Objective Morphological Volume and VAS Scores

During the early stage of postoperative recovery (d1–d14), both objective morphological volume and VAS scores effectively captured the overall decreasing trend of postoperative swelling. In the middle and late stages of postoperative recovery (d14–d28), objective morphometric imaging maintained high sensitivity (SRM = 3.788–4.437) and was able to accurately detect subtle changes in residual mild swelling. Although the SRM of VAS scores ranged from 0.902 to 1.355, most patients' VAS scores approached zero at day 28, indicating a pronounced floor effect. This limited its ability to distinguish the small fluctuations of residual swelling and reduced its evaluative utility in the mid-late postoperative period (Table 3).

Discussion

Accurate assessment of postoperative swelling is fundamental to clinical decision-making after upper blepharoplasty. Persistent or abnormal edema may be associated with complications such as hematoma or infection, while overestimation of swelling may lead to unnecessary interventions [1]. At present, clinical evaluation of periorbital swelling still relies largely on clinicians' subjective judgment or semi-quantitative tools such as VAS, and there remains a lack of objective methods for precise quantification of periorbital volume changes. Only a study has applied 3D-SPG to assess volumetric changes after blepharoplasty [9]. This study retrospectively compared the performance of 3D-SPG and VAS in evaluating postoperative swelling. Based on the analysis intervals (d1–d7, d7–d14, and d14–d28), both methods effectively captured the overall reduction in swelling during the early postoperative phase (d1–d7 and d7–d14). Notably, 3D-SPG demonstrated consistently higher responsiveness across all time intervals (SRM = 3.406–5.007), whereas VAS showed good responsiveness in the early stages but a marked decline in the late interval (d14–d28), potentially due to a floor effect. These temporal differences in sensitivity provide useful insights for optimizing postoperative monitoring strategies.

First, we analyzed temporal changes in objective morphological volume, VAS scores, and double-eyelid fold width, all of which demonstrated a consistent decline over time, in line with the expected clinical course of postoperative recovery. Second, we evaluated the correlation between 3D-SPG measurements and VAS scores. The results showed a dynamic relationship over time: a significant positive correlation was observed in the early postoperative period (d1, d7), whereas this correlation weakened and became non-significant in the late postoperative period (d14, d28). This finding is consistent with observations in the facial plastic surgery literature indicating that objective measurements and subjective assessments do not always align. For instance, Mulder *et al*. [18] reported a negligible correlation (ρ = 0.20) between objective aesthetic assessments and patient-reported satisfaction, suggesting that factors influencing patient satisfaction cannot be fully captured by objective measures alone. This discrepancy may be attributed to inherent heterogeneity among patients, including individual differences in recovery rate, pain sensitivity, and type of tissue response. Such variability may lead to different subjective–objective correspondence across individuals at the same postoperative time point, thus presenting a statistically poor correlation in the overall analysis. During the early postoperative intervals (d1–d7 and d7–d14), both methods effectively captured the overall declining trend of postoperative swelling. In the late interval (d14–d28), objective morphological volume measurements remained highly responsive, whereas the sensitivity of VAS score decreased. This may be attributed to the fact that VAS score for most patients approached zero at day 28, indicating a potential floor effect, which limited its ability to detect small fluctuations in residual swelling and its utility in the late postoperative period. This is a well-recognized limitation of subjective rating scales, in which scores cluster at the lower end and fail to capture subtle yet clinically meaningful changes [19].

In addition, 3D-SPG can capture detailed spatial information, such as asymmetric swelling or focal edema. However, it has several limitations. First, the technique requires specialized equipment and software, which may be prohibitively expensive for small practices. Second, consistent positioning of the measurement region remains challenging, as minor variations in contour placement can introduce measurement errors, a limitation that is not unique to this study. Creasman *et al*. [20,21] identified manual landmarking as a major source of variability in 3D imaging and proposed an automated anatomical registration system to address this limitation. Future versions of 3D-SPG systems should integrate such automated functions to improve reproducibility. Furthermore, deep tissue edema cannot be directly assessed using this technique, and a comprehensive assessment may require complementary imaging modalities such as ultrasound or magnetic resonance imaging (MRI).

Several limitations of this study should be acknowledged. First, this was a single-center retrospective study with a relatively small sample size, which may limit the generalizability of the findings to similar patients undergoing primary cosmetic blepharoplasty, rather than patients with more complex eye diseases. Future prospective, multicenter studies with larger and more diverse cohorts are needed to address these shortcomings. Second, we did not explore the relationship between objective morphologic volume changes and clinical outcomes such as patient satisfaction or postoperative complications, which represents an important direction for future research and would further clarify the clinical relevance of 3D-SPG. Third, a floor effect was evident in the late-stage VAS scores, highlighting the limitations of conventional subjective scales in detecting subtle residual changes during advanced recovery. Future studies should consider incorporating more sensitive and multidimensional assessment tools to better capture patient-reported outcomes. Fourth, the sex distribution in our cohort (7 males and 32 females) was markedly imbalanced. Given that biological sex may influence postoperative inflammatory responses and subjective symptom reporting, this represents a potential confounding factor that was not adjusted for in our analysis. Consequently, the generalizability of our findings, particularly regarding the absolute magnitude of swelling and VAS scores, may be limited. Future studies with more balanced cohorts, or those specifically designed to investigate sex-based differences, are warranted to validate our conclusions. In addition, integrating 3D-SPG with other objective modalities, such as ultrasound for deep tissue assessment, may enable a multimodal assessment approach that captures both superficial and subcutaneous changes in postoperative swelling.

Representative Case

To better illustrate our findings, we present a representative case. A 28-year-old female patient underwent blepharoplasty with double-eyelid formation in our department. At postoperative day 28, the patient reported that the perceived swelling had not significantly decreased compared with that at postoperative day 7. The 3D-SPG imaging was used to compare the swelling at postoperative days 7 and 28

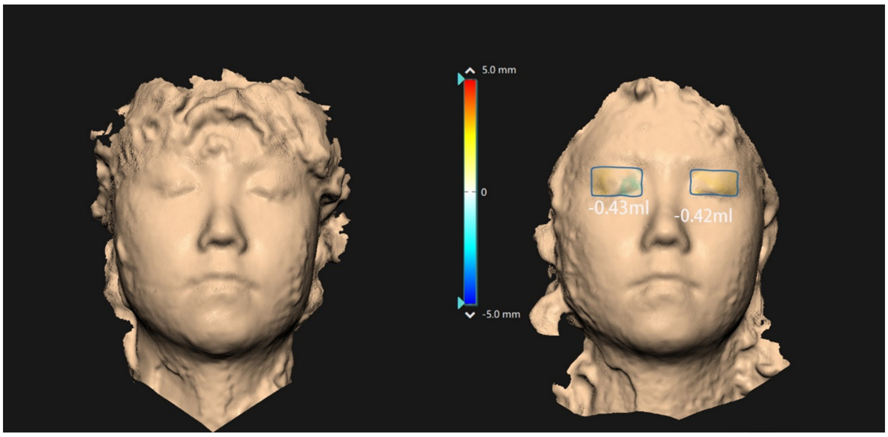

Fig. 2. Degree of swelling reduction at postoperative day 7 compared with day 1 (baseline at postoperative day 1).

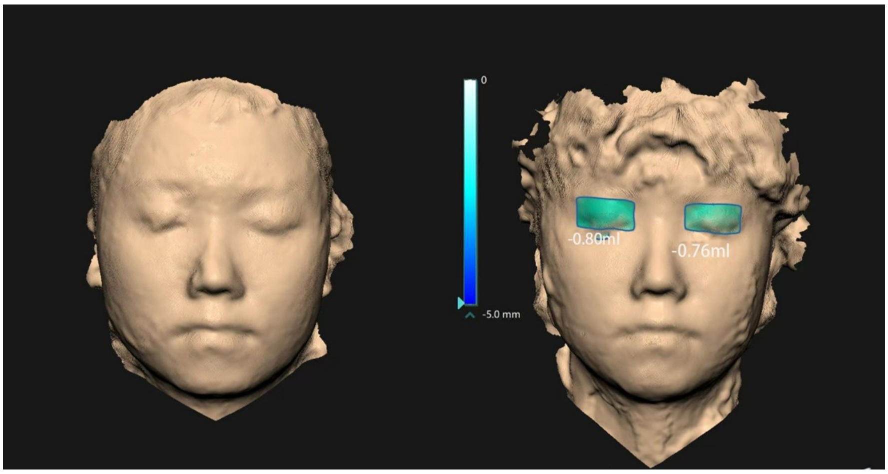

Fig. 3. Degree of swelling reduction at postoperative day 28 compared to day 1 (baseline at postoperative day 1).

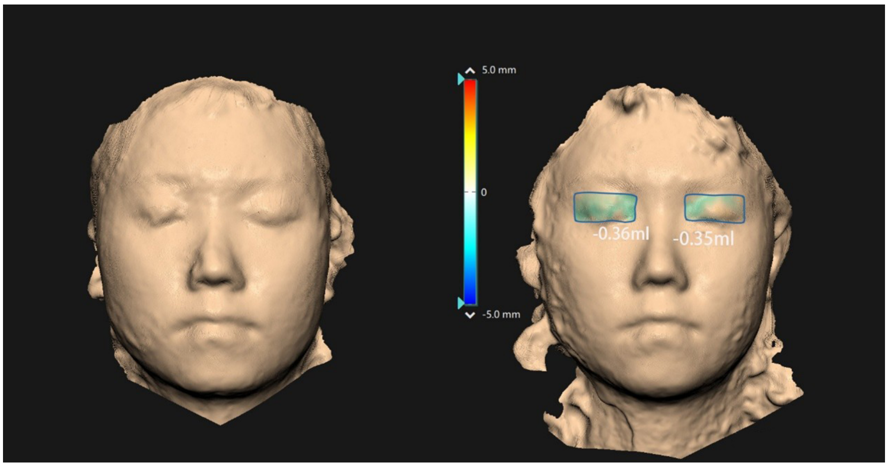

Fig. 4. Degree of swelling reduction at postoperative day 28 compared to day 7 (baseline at postoperative day 7).

(Figs. 2,3,4). Informed consent was obtained from the patient.

Conclusions

Both 3D-SPG and VAS demonstrate distinct performance characteristics across postoperative stages. 3D-SPG provides objective, quantitative volumetric data, whereas VAS reflects patient-perceived symptoms. These findings suggest that the two approaches assess different dimensions of postoperative swelling; however, further studies are needed to determine whether their combined use offers additional clinical benefit. Future research should further explore the correlation between objective morphological changes and patient-reported outcomes, such as satisfaction and quality of life, as well as clinical endpoints, including complication rates and long-term aesthetic results, to facilitate the in-depth clinical application of this technique in aesthetic surgery.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

Chang G and JLH designed the research study. Chen G, YFZ, and KXY performed the research. KL and Chang G analyzed the data. JLH drafted the article. All authors have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Jiangsu Province Hospital of Chinese Medicine, Affiliated Hospital of Nanjing University of Chinese Medicine (approval number: 2025NL-064-02), and all procedures followed the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients for their participation in the study.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Fang S, Zhu W, Xing X, Zhu L, Yang C. Double eyelid surgery by using palpebral marginal incision technique in Asians. Journal of Plastic, Reconstructive & Aesthetic Surgery: JPRAS. 2018; 71: 1481–1486. https://doi.org/10.1016/j.bjps.2018.05.035.

[2] Bannister JJ, Wilms M, Aponte JD, Katz DC, Klein OD, Bernier FP, *et al*. Comparing 2D and 3D representations for face-based genetic syndrome diagnosis. European Journal of Human Genetics: EJHG. 2023; 31: 1010–1016. https://doi.org/10.1038/s41431-023-01308-w.

[3] Pellitteri F, Scisciola F, Cremonini F, Baciliero M, Lombardo L. Accuracy of 3D facial scans: a comparison of three different scanning system in an in vivo study. Progress in Orthodontics. 2023; 24: 44. https://doi.org/10.1186/s40510-023-00496-x.

[4] Aynechi N, Larson BE, Leon-Salazar V, Beiraghi S. Accuracy and precision of a 3D anthropometric facial analysis with and without landmark labeling before image acquisition. The Angle Orthodontist. 2011; 81: 245–252. https://doi.org/10.2319/041810-210.1.

[5] Hajeer MY, Millett DT, Ayoub AF, Siebert JP. Applications of 3D imaging in orthodontics: part I. Journal of Orthodontics. 2004; 31: 62–70. https://doi.org/10.1179/146531204225011346.

[6] Guo Y, Hou X, Rokohl AC, Jia R, Heindl LM. Reliability of Periocular Anthropometry: A Comparison of Direct, 2-Dimensional, and 3-Dimensional Techniques. Dermatologic Surgery. 2020; 46: e23–e31. https://doi.org/10.1097/dss.0000000000002243.

[7] Kim BR, Kim M, Kim JW, Shin JW, Na JI, Huh CH. Efficacy and Safety of the Micro-insulated Needle Radiofrequency Device for Reduction of Submental Fat. Dermatologic Surgery. 2023; 49: 389–394. https://doi.org/10.1097/DSS.0000000000003723.

[8] Nikolis A, Bertucci V, Solish N, Lane V, Nogueira A. An Objective, Quantitative Assessment of Flexible Hyaluronic Acid Fillers in Lip and Perioral Enhancement. Dermatologic Surgery. 2021; 47: e168–e173. https://doi.org/10.1097/DSS.0000000000002917.

[9] Figueiredo MND, Limongi RM, Tao JP. A Prospective Randomized Study of Lateral Brow-Eyelid Complex Volume after Internal Browpexy Using Three-Dimensional Stereophotogrammetry. Facial Plastic Surgery & Aesthetic Medicine. 2024; 26: 288–293. https://doi.org/10.1089/fpsam.2020.0586.

[10] Rijsbergen M, Pagan L, Niemeyer-van der Kolk T, Rijneveld R, Hogendoorn G, Lemoine C, *et al*. Stereophotogrammetric three-dimensional photography is an accurate and precise planimetric method for the clinical visualization and quantification of human papilloma virus-induced skin lesions. Journal of the European Academy of Dermatology and Venereology: JEADV. 2019; 33: 1506–1512. https://doi.org/10.1111/jdv.15474.

[11] Skvara H, Burnett P, Jones J, Duschek N, Plassmann P, Thirion JP. Quantification of skin lesions with a 3D stereovision camera system: validation and clinical applications. Skin Research and Technology: Official Journal of International Society for Bioengineering and the Skin (ISBS) [and] International Society for Digital Imaging of Skin (ISDIS) [and] International Society for Skin Imaging (ISSI). 2013; 19: e182–e190. https://doi.org/10.1111/j.1600-0846.2012.00625.x.

[12] Rappl T, Wurzer P, May S, Tuca AC, Cambiaso-Daniel J, Parvizi D, *et al*. Three-Dimensional Evaluation of Static and Dynamic Effects of Botulinum Toxin A on Glabellar Frown Lines. Aesthetic Plastic Surgery. 2019; 43: 206–212. https://doi.org/10.1007/s00266-018-1230-y.

[13] Machado BHB, De Melo E Silva ID, Pautrat WM, Frame J, Najlah M. Scientific validation of three-dimensional stereophotogrammetry compared to the IGAIS clinical scale for assessing wrinkles and scars after laser treatment. Scientific Reports. 2021; 11: 12385. https://doi.org/10.1038/s41598-021-91922-9.

[14] Ceinos R, Tardivo D, Bertrand MF, Lupi-Pegurier L. Inter- and Intra-Operator Reliability of Facial and Dental Measurements Using 3D-Stereophotogrammetry. Journal of Esthetic and Restorative Dentistry: Official Publication of the American Academy of Esthetic Dentistry ... [et Al.]. 2016; 28: 178–189. https://doi.org/10.1111/jerd.12194.

[15] Guo Y, Rokohl AC, Fan W, Theodosiou R, Li X, Lou L, *et al*. A novel standardized approach for the 3D evaluation of upper eyelid area and volume. Quantitative Imaging in Medicine and Surgery. 2023; 13: 1686–1698. https://doi.org/10.21037/qims-22-589.

[16] Buitenhuis MB, Klijn RJ, Rosenberg AJWP, Speksnijder CM. Reliability of 3D Stereophotogrammetry for Measuring Postoperative Facial Swelling. Journal of Clinical Medicine. 2022; 11: 7137. https://doi.org/10.3390/jcm11237137.

[17] Nishioka H, Takashimizu I, Yuzuriha S. Upper eyelid lymphatic anatomy is associated with blepharoplasty recovery. Journal of Plastic, Reconstructive & Aesthetic Surgery: JPRAS. 2024; 99: 248–255. https://doi.org/10.1016/j.bjps.2024.09.079.

[18] Mulder FJ, Mosmuller DGM, de Vet RHCW, Don Griot JPW. Aesthetics Assessment and Patient Reported Outcome of Nasolabial Aesthetics in 18-Year-Old Patients With Unilateral Cleft Lip. The Cleft Palate-craniofacial Journal: Official Publication of the American Cleft Palate-Craniofacial Association. 2019; 56: 1058–1064. https://doi.org/10.1177/1055665619832439.

[19] Bharadia SK, Gabriel V. Comparison of Clinical Estimation and Stereophotogrammic Instrumented Imaging of Burn Scar Height and Volume. European Burn Journal. 2024; 5: 38–48. https://doi.org/10.3390/ebj5010004.

[20] Creasman CN, Mordaunt D, Liolios T, Chiu C, Gabriel A, Maxwell GP. Four-dimensional breast imaging, part I: introduction of a technology-driven, evidence-based approach to breast augmentation planning. Aesthetic Surgery Journal. 2011; 31: 914–924. https://doi.org/10.1177/1090820X11423916.

[21] Creasman CN, Mordaunt D, Liolios T, Chiu C, Gabriel A, Maxwell GP. Four-Dimensional Breast Imaging, Part II: Clinical Implementation and Validation of a Computer Imaging System for Breast Augmentation Planning. Aesthetic Surgery Journal. 2011; 31: 925–938. https://doi.org/10.1177/1090820x11424147.