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ORIGINAL RESEARCH

Correction of Mild-to-Moderate Sunken Upper Eyelids of Asians with Stromal Vascular Fraction Gel

Feixue Ding · Yirui Shen · Lin Lu · Di Sun · Xusong Luo · Xiao Liang · Jun Yang · Rui Jin

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ABSTRACT

Introduction: Fat grafting is an efficient and safe procedure for the correction of upper eyelid sulcus deepening. Stromal vascular fraction (SVF) gel has been proven to be an ideal fat derivative and can be widely used for facial augmentation. We aimed to determine the efficacy of SVF gel for the correction of a mild-to-moderate sunken superior sulcus among Asian patients.

Methods: Patients with a mild-to-moderate sunken superior sulcus underwent SVF gel grafting of the sunken upper periorbital area. The primary result was the quantitative volume difference in the superior sulcus region before and after grafting. This was evaluated through three-dimensional VECTRA® imaging. The secondary results included the aesthetic quantitative evaluation results (upper lid area and pretarsal space ratio), global aesthetic improvement scale (GAIS) score, and complications.

Results: Thirty-one patients with mild-to-moderate sunken upper eyelids were included in this study. The average unilateral injected amount was 1.235 mL (± 0.171 mL). The 1-year delta volume was 0.801 ± 0.086 mL, and the effective survival volume was 65.3% (± 6.1%). The median preoperative pretarsal space and upper lid area ratio was 1.010 (± 0.150). The median postoperative pretarsal space and upper lid area ratio at 1 year was 0.159 (± 0.031) ($n = 62$; $P < 0.0001$), indicating a significantly reduced sunken appearance. The average GAIS score was 2.174 (± 0.391). All patients were satisfied with their surgical outcomes. The reoperation rate was 12.9%.

Conclusions: SVF gel is safe and effective for the treatment of a mild-to-moderate sunken superior sulcus and is associated with satisfactory clinical outcomes and short recovery times.

Keywords: Oculoplastics; Stromal vascular fraction gel; Upper eyelid sulcus

Feixue Ding and Yirui Shen contributed equally to the acquisition, analysis, and treatment of data and should be viewed as co-first authors.

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Key Summary Points

Why carry out this study?

Fat grafting is the preferred solution for a sunken upper eyelid; however, complications such as nodules and fat necrosis can occur, and the survival rate of fat is unstable.

New fat derivatives, such as stromal vascular fraction (SVF) gel, could be used for the treatment of the sunken upper eyelid.

The efficacy and safety of SVF gel for treating the mild-to-moderate sunken upper eyelid have not been clinically clarified.

What was learned from the study?

SVF gel is a new fat derivative with a stable survival rate when used for grafting of the sunken upper eyelid.

SVF gel grafting of the upper eyelid can effectively correct the mild-to-moderate sunken upper eyelid with satisfactory clinical results and no obvious complications, thereby achieving optimal aesthetic outcomes.

DIGITAL FEATURES

This article is published with digital features, including a video, to facilitate understanding of the article. To view digital features for this article go to https://doi.org/10.6084/m9.figshare.21507741.

INTRODUCTION

Two main contributors to facial aging are the volume loss of soft tissue and deformation of the bony structure [1]. Sunken superior sulcus occurs with the volume loss of soft tissue, redundant eyelid skin, and loss of skin elasticity. It presents as the hollowing of the upper eyelid sulcus, especially in the medial part, and a skeletonized appearance of the upper eyelid [2, 3]. Traditional blepharoplasty and brow lifting are intended for excising excessive eyelid skin and muscle; therefore, they have little effect on or can even worsen the sunken appearance [2, 4]. Methods of correcting sunken upper eyelids, including the use of autologous fat grafting, dermal filler, and various surgical techniques to transfer a tissue flap to revolumize the sunken area, have proven effective [2, 3, 5, 6]. However, the upper eyelid region has a unique anatomy that comprises thin eyelid skin, layered fat tissue composed of a retro-orbicularis oculi fat (ROOF) layer and a pre-aponeurotic fat layer, and the levator aponeurosis and Müller muscles, which are located behind the pre-aponeurotic fat [7–11]. As the upper periorbital region is a dynamic area, fat grafting must be accurate and refined to avoid an unnatural and bloated appearance with eyelid movement and injury of the levator aponeurosis, which leads to iatrogenic ptosis [8, 12, 13].

As a result of the complexity of eyelid anatomy and the demand for an accurate procedure, autologous fat grafting has gained popularity. This is because of its availability, cost-effectiveness, and technical feasibility. Moreover, purification of the adipose tissue is considered to improve fat grafting outcomes. Coleman fat, which is processed using a standard technique comprising aspiration, centrifugation, and grafting, is effective for periorbital grafting [14–16]. However, other studies of fat grafting in the periorbital region with Coleman fat have reported various postoperative complications, including persistent edema, fatty nodules, cysts, calcification, and asymmetric fat displacement [3, 17, 18]. In 2016, a novel fat-derived stromal vascular fraction (SVF) gel that retains a higher percentage of the stromal vascular fraction and stem cells was developed by Feng Lu and his team. It has a good retention rate especially compared to Coleman fat [19–21]. One study revealed that SVF gel has smaller adipocytes and higher resistance after mechanical processing compared to Coleman fat, thus indicating that SVF could be used for procedures requiring

precision, such as those associated with periorbital grafting [22].

We conducted a pilot clinical study to evaluate the safety and efficacy of SVF gel for the correction of upper eyelid sulcus deepening. We also evaluated the volume improvement, aesthetics, and complications associated with the use of SVF gel for 31 Asian patients.

METHODS

This study was approved by a local institutional review board and ethics committee, and it adhered to the tenets of the Declaration of Helsinki (SH9H-2019-T213-3). The study included 31 patients with a mild-to-moderate upper eyelid sulcus deepening who had received bilateral SVF gel grafting, from December 2019 to July 2021, at Shanghai Ninth People's Hospital which is affiliated with Shanghai Jiaotong University School of Medicine. All patients were photographed and underwent imaging (VECTRA®XT imaging system; Canfield Scientific, Inc., Parsippany, NJ, USA) before surgery and 1 year postoperatively. Informed consent was obtained from all patients.

We included patients who met the following criteria: they had (i) an upper eyelid sulcus deepening (mild-to-moderate severity); (ii) no sign of scar or adhesion of the upper eyelid skin; (iii) no history of surgery of the upper eyelid area, such as blepharoplasty and brow lift; and (iv) age older than 18 years.

The exclusion criteria were as follows: they had (i) received botulin toxin or dermal filler in the upper face area within the last 1 year; (ii) an upper eyelid sulcus deepening caused by orbital fractures; (iii) Graves ophthalmopathy, ptosis, or severe laxity of the upper eyelid skin; (iv) any disease with the potential to cause a change in weight; (v) a change in weight of more than 10 pounds during the follow-up period.

Surgical Technique

Surgery was performed by experienced fellow physicians affiliated with Shanghai Ninth People's Hospital. Before surgery, the depressed region of the upper eyelid sulcus was marked with a blue marker while the patient was in the sitting position. After the application of tumescent anesthesia, a multiperforated cannula (Sorensen Harvester™; Tulip Aesthetics, West Caldwell, NJ, USA) with a 2.4-mm diameter and 20-cm length was used to harvest fat from the abdomen or inner thigh. Lipoaspirates were obtained and processed into SVF gel [20]. Sedimented fat was first centrifuged for 3 min at 1200 × *g*. After draining, fat tissue was mechanically emulsified using two 10-mL syringes and a female-to-female Luer-Lock connector with a 2.4-mm internal diameter. Subsequently, the fat emulsion was centrifuged a second time for 3 min at 2500 × *g* (Fig. 1a). Finally, the SVF gel was isolated in the lowest layer (Fig. 1b).

We injected 0.5 mL of 2% lidocaine into each side of the patient's upper periorbital region. After the application of complete anesthesia, a 2-mm incision was made near the junction of the lateral orbital rim and brow arch. Then, SVF gel was injected with a 1-mL syringe through a 25-G cannula into the depressed region of the upper eyelid and the ROOF layer (Fig. 2a). The SVF gel was injected by constantly retracting the cannula in a zigzag manner while applying minimal pressure to avoid a bolus. The injected amount was determined during the procedure with an empirical overcorrection of 30% and then recorded. After the injection, we massaged the upper eyelid softly to help spread the filler. The plane of the injection was the ROOF plane beneath the orbicularis oculi muscle and septum (Fig. 2b). Details of the surgical procedure are shown in Video 1 (see the online/HTML version of the manuscript).

Preoperative and Postoperative Evaluations

Patients were required to undergo the following both before and after the surgery: photographic and severity grading evaluations; imaging (VECTRA®XT imaging system; Canfield Scientific, Inc.); global aesthetic improvement scale grading by the patient and physician; and

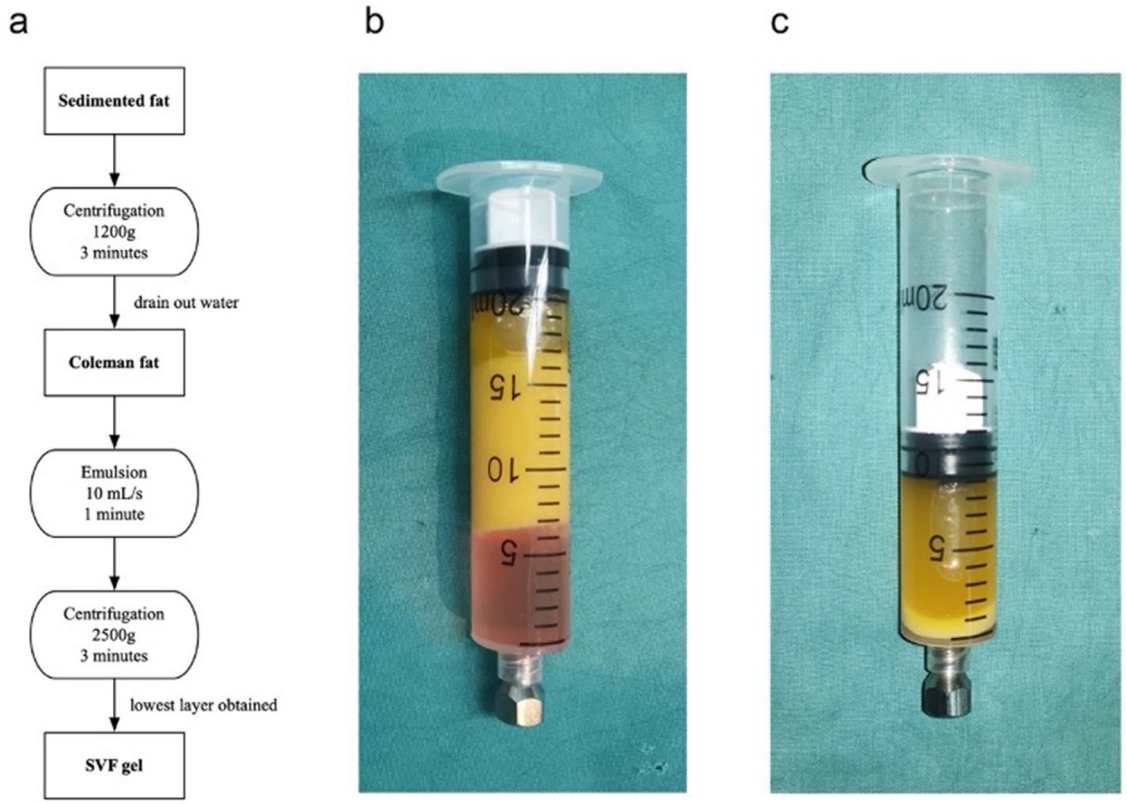

Fig. 1 **a** Standardized protocol using stromal vascular fraction (SVF) gel. **b** Coleman fat obtained after centrifugation at 1200 × *g* for 3 min. **c** SVF gel obtained after emulsion and centrifugation

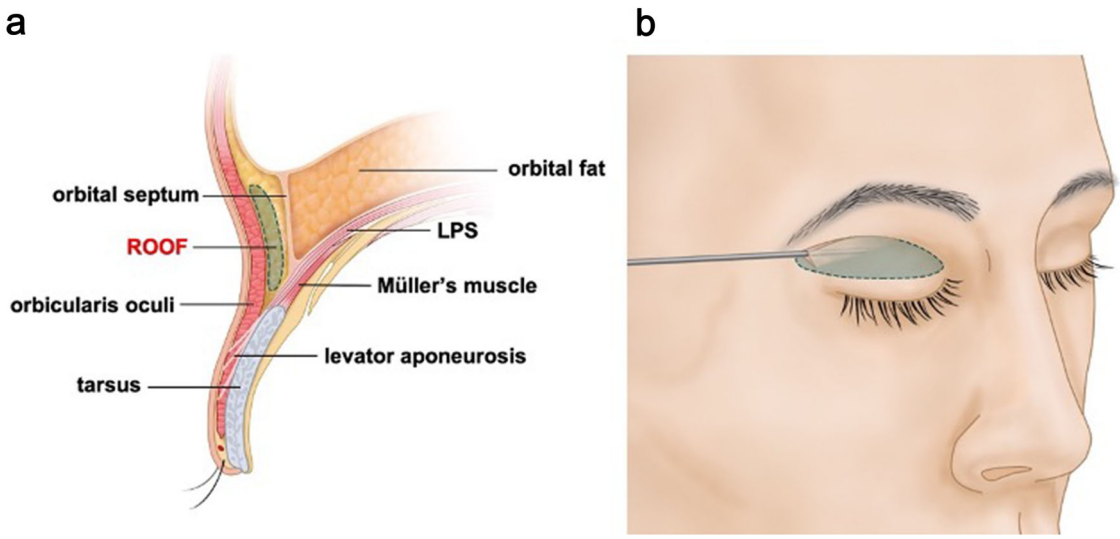

Fig. 2 **a** Diagram of the upper eyelid anatomy and the injection plan. ROOF, retro-orbicularis oculi fat. LPS, levator palpebrae superioris. **b** Stromal vascular fraction (SVF) gel was injected in the ROOF of the upper eyelid through a 2-mm incision near the junction of the lateral orbital rim and brow arch Figure credit: Min Liu

evaluation of the relevant patient information and complications.

The severity of the upper eyelid sulcus deepening was graded before surgery by measuring the horizontal distance from the inferior extended line of the superior orbital rim to the most sunken point of the upper eyelid in the side profile. A single eye was evaluated as a single sample. The sunken depths were graded as follows: less than 5 mm, mild; between 5 and 10 mm, moderate; and more than 10 mm, severe [23]. The study only included patients with a mild or moderate upper eyelid sulcus deepening.

Photographs of the left profile view, frontal view, and right profile view were obtained preoperatively and at 7 days, 3 months, and 1 year postoperatively. During future replications of this study, the standard follow-up period should be at least 1 year.

Evaluation of Volume Improvement

After surgery, the amount of SVF gel injected in a unilateral eye was recorded. All patients underwent imaging of the upper eyelid to the supraorbital rim with eyes opened (VECTRA®XT imaging system; Canfield Scientific, Inc.) preoperatively and at 1 year postoperatively. Data were processed by two independent observers using a standard desktop computer utilizing the software supplied with the VECTRA M3 (VECTRA 3D analysis module; Canfield Scientific, Inc.). The three-dimensional models that were generated are best described as high-resolution surface maps of the face.

VECTRA images and photographs were obtained with patients in a standardized and reproducible position. After acquisition of the surface map of the face preoperatively and 1 year postoperatively, the volume difference was measured. The volumetric change was measured in milliliters and calculated as the difference between the two registered surface maps at a certain area. Four margins were used to select the area from upper eyelid to the supraorbital rim more accurately. These were the lower edge of the eyebrow, upper palpebral margin, the line between the outer canthus and the highest point of the eyebrow arch, and the line between the inner canthus and the inner corner of brow (Fig. 3).

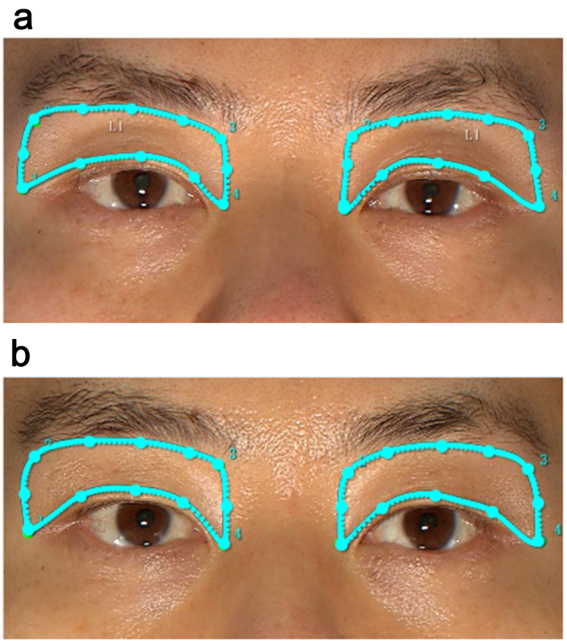

Fig. 3 A certain area was selected to compare the volume difference. The following margins were used: the lower edge of the eyebrow; upper palpebral margin; the line between the outer canthus and the highest point of the eyebrow arch; and the line between the inner canthus and the inner corner of brow. **a** Preoperative photo. **b** Photo at 1 year postoperatively

The VECTRA®XT imaging system (Canfield Scientific, Inc.) was useful for calculating the volume change (referred to as the 1-year delta volume) of the region of the upper eyelid of each eye to the supraorbital rim based on the images obtained preoperatively and 1 year postoperatively (Fig. 4).

The effective survival volume was calculated using the following formula:

$$\text{Effective survival volume} = 1 - \text{year delta volume/injected volume of SVF gel} \times 100\%$$

Aesthetic Improvement Evaluation

The distance ratio of the pretarsal space and upper eyelid area was used to evaluate the aesthetic improvement (referred to as the pretarsal space and upper eyelid area ratio). In the frontal

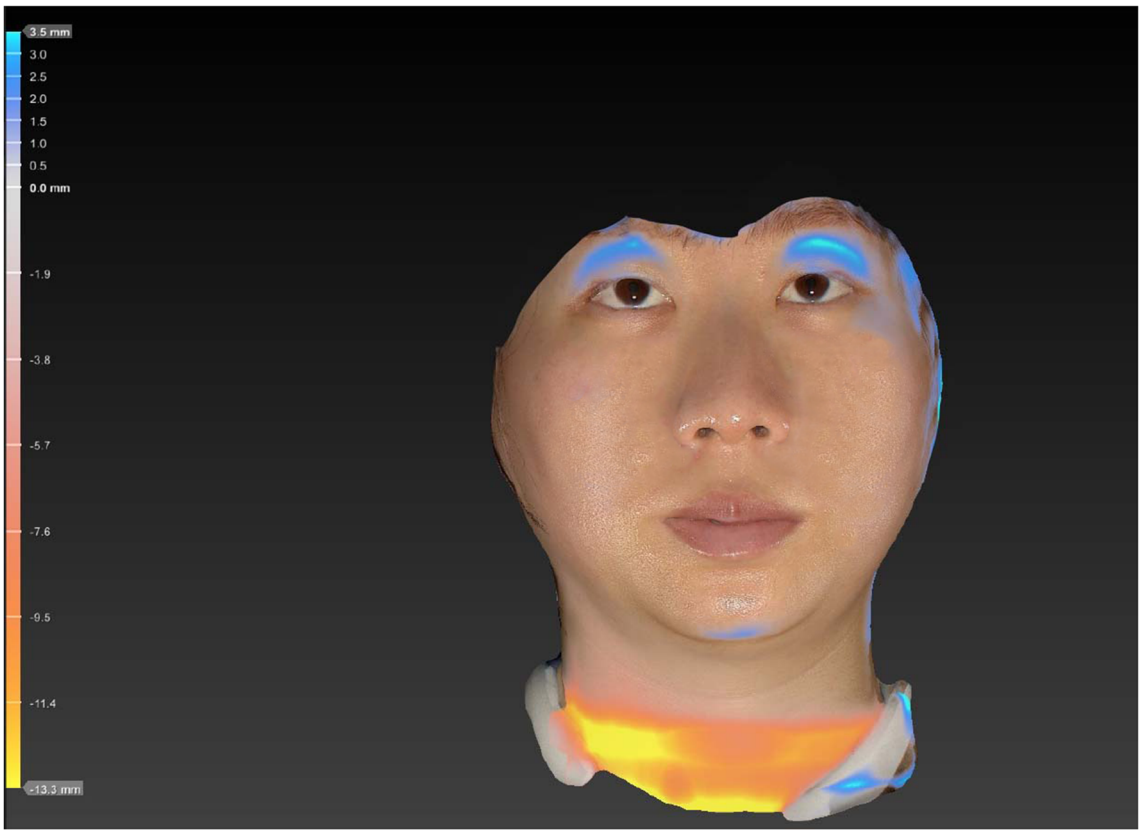

Fig. 4 Volumetric measurements performed using the VECTRA®XT imaging system. The volume change was calculated on the basis of a comparison of the preoperative and postoperative images. The blue region shows the postoperative increase in volume

view, we set the distance from the brow arch to the most depressed point of the upper eyelid as *a* and the distance from the most depressed point of the upper eyelid to the upper eyelid margin as *b*. If the most depressed point of the upper eyelid was not obvious after surgery, then the sunken point was set at the double eyelids line or 1 mm above the single upper eyelid margin (Fig. 5).

The pretarsal space and upper eyelid area ratio was calculated as the mean of *b*/*a*. This ratio denoted the severity of the upper eyelid sulcus deepening: the larger the value, the more sunken the upper eyelid. The pretarsal space and upper eyelid area ratio was measured at the middle of the pupil both preoperatively and 1 year postoperatively.

GAIS Assessment

Surgical improvement observed during follow-up was assessed on the basis of photographic records, the reporting of patients, and the reporting of three professional plastic surgeons who were blinded to the surgical procedure using the GAIS score (Table 1) [24]. The GAIS score was calculated as the average of the scores determined by the patients and physicians (GAIS score = average of the GAIS scores assessed by three physicians plus the score assessed by patient/2).

Assessment of Complications

The incidence of adverse events during follow-up (at least 1 year postoperatively) was assessed. Complications included bruises, persistent edema, infection, palpable granules, asymmetry, and ptosis.

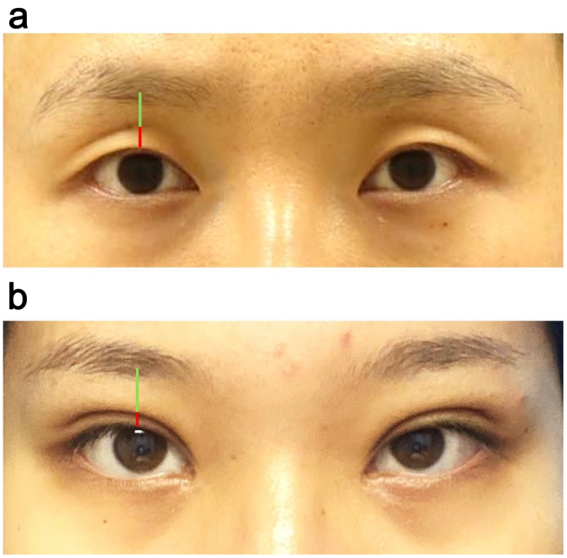

Fig. 5 Upper lid area and pretarsal space ratio. The green line indicates the distance from the brow arch to the most depressed point of the upper eyelid (point *a*); the red line indicates the distance from the most depressed point of the upper eyelid to the upper eyelid margin (point *b*). The pretarsal space and upper eyelid area ratio was calculated as the *b*/*a* value. The pretarsal space and upper lid area ratio of a patient **a** with a sunken upper sulcus and **b** without a sunken upper sulcus. The value indicates the severity of the upper eyelid sulcus deepening. The lower the pretarsal space and upper lid area ratio, the less sunken the sulcus

Table 1 Global aesthetic improvement scale (GAIS)

Score	Grade	Definition
− 1	Worse	Appearance worse than the original condition or with complications
0	No change	Appearance essentially the same as the original condition
1	Improved	Obvious improvement, but touch-up or re-treatment is indicated
2	Much improved	Marked improvement in the condition, but not optimal for the patient; a touch-up would slightly improve the outcome
3	Very much improved	Optimal cosmetic result for the patient

Sample Size Calculation

The sample size (number of patients) was calculated using the following formula:

$$N = z^2_{1-\alpha/2} * \sigma / d^2,$$

where $z_{1-\alpha/2}$ is the standardized value for the corresponding level of confidence (using a 95% confidence interval, it is 1.96), d is the survival of the SVF gel based on previous research (set as 70%) [6, 19], σ is the standard deviation of the survival of the fat graft (based on previous study and set as 30%) [14]. This formula indicated that the necessary sample size was 21 patients. Owing to a 20% dropout rate, the minimal sample size was enlarged to 26.

Statistical Methods

The evaluation data were calculated as mean ± standard deviation and further analyzed using Welch's *t* test if necessary. A *p* value less than 0.05 was considered statistically significant. The analyses were performed using SPSS version 22.0 (IBM SPSS Inc., Chicago, IL, USA).

RESULTS

Twenty-eight female and three male patients were included in the study; their average age was 37.67 years (± 4.10 years). Fat tissue was obtained from the abdomen of 15 patients and from the thigh of 16 patients. The average total follow-up period was 15.33 months (± 4.821 months; range 12–28 months). For further evaluation, a single eye was considered a single sample. Thirty-seven eyes had a mild upper eyelid sulcus deepening and twenty-five had a moderate upper eyelid sulcus deepening. The average sunken depth was 6.156 mm (± 1.964 mm; n = 62). The demographic characteristics of the patients are presented in Table 2. All patients received bilateral fat grafting with SVF gel with an average unilateral injection volume of 1.235 mL (± 0.171 mL; range 0.8–2.0 mL; n = 62). The 1-year delta

Table 2 Demographic characteristics of the patients

Number of patients	31
Average age (years)	37.67 ± 4.10
Male/female	3/28
Number of eyes	62
Upper eyelid sulcus severity	
Mild	37
Moderate	25
Average sunken depth (mm)	6.156 ± 1.964

volume of each sample was 0.801 mL (± 0.086 mL), and the effective survival volume was 65.3% (± 6.1%; $n = 62$). The median preoperative pretarsal space and upper lid area ratio (b/a value) was 1.010 (± 0.150). The median pretarsal space and upper lid area ratio at 1 year postoperatively was 0.159 (± 0.031; $n = 62$; $P < 0.0001$). After surgery, the pretarsal space and upper lid area ratio was significantly reduced, indicating that the depression of the upper eyelid significantly improved.

The average GAIS score was 2.235 (± 0.741; $n = 31$). During follow-up, bruises and edema were observed early; however, other severe complications were not observed. The experience of two patients involved asymmetry (undercorrection of one side), and both requested a second injection to obtain a better appearance. The reoperation rate was 12.9% ($n = 31$) (Tables 3, 4, 5).

Table 3 Effects of SVF gel injection on volume change

	Value (mean ± SD)
Average unilateral injection volume (mL)	1.235 ± 0.171
Delta volume at 1 year (mL)	0.801 ± 0.086
Effective survival volume (%)	65.3 ± 6.1

SVF stromal vascular fraction, *SD* standard deviation

Table 4 Change in the pretarsal space and upper lid area ratio (b/a value)

	***b/a* value (mean ± SD)**
Preoperative	1.010 ± 0.150
Postoperative	0.159 ± 0.031
P value[a]	< 0.0001

SD standard deviation
[a]*P* value of the pretarsal space and upper lid area ratio preoperatively and at 6 months postoperatively

Table 5 Complications

Complication	**Patients, no. (%)**
Bruises[a]	12 (38.7%)
Edema[b]	6 (19.4%)
Infection	0
Palpable granules	0
Asymmetry	2 (6.5%)
Ptosis	0

[a]Bruises lasting more than 14 days
[b]Edema lasting more than 1 month

Case 1

A 34-year-old man presented with a moderate bilateral upper eyelid sulcus deepening. We injected 1.5 mL of SVF gel in the upper periorbital region bilaterally. By 1 year postoperatively, the volume change was 0.726 mL on the right side, and 0.609 mL on the left side. The mean preoperative pretarsal space and upper lid area ratios were 1.625 and 1.938 on the right and left sides, respectively. The pretarsal space and upper lid area ratios at 1 year postoperatively were 0.026 and 0.023 on the right and left sides, respectively. The patient's GAIS score was 3 (Figs. 6, 7).

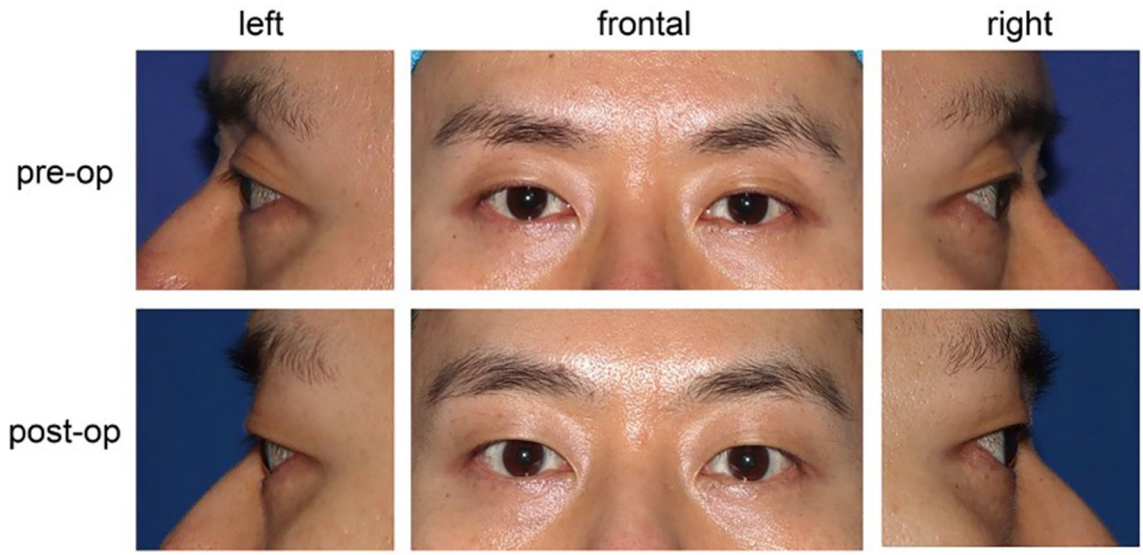

Fig. 6 A 34-year-old man with a moderate bilateral upper eyelid sulcus deepening. We injected 1.5 mL of stromal vascular fraction (SVF) gel in the upper periorbital region bilaterally. The postoperative photos were obtained at 1 year. Left column, left side view; middle column, frontal side view; right column, right side view

Case 2

A 35-year-old woman presented with a moderate left upper eyelid sulcus deepening and mild right upper eyelid sulcus deepening. We injected 1.5 mL of SVF gel in the left upper sulcus and 1.2 mL of SVF gel in the right upper sulcus. By 1 year postoperatively, the volume change on the right side was 0.638 mL, and that on the left side was 0.678 mL. The preoperative pretarsal space and upper lid area ratios were 0.744 and 0.835 on the right and left sides, respectively. The pretarsal space and upper lid area ratios at 1 year postoperatively were 0.074 and 0.085 on the right and left sides, respectively. The patient's GAIS score was 2.25 (Figs. 8, 9).

DISCUSSION

Graft survival rate is a crucial parameter when evaluating the efficacy of fat grafting; however, because the volume change of the upper sulcus is difficult to measure, these data have not yet been reported. To our knowledge, our pilot study is the first attempt to report such data. According to our research, the effective survival volume of SVF gel after injection in the periorbital region was 65.3% (± 13.1%). Furthermore, a recent study reported that the retention rate of the SVF gel graft to correct the tear trough was approximately 70% [24]. This difference in the survival rate may be attributable to different facial sites and possible errors caused by the use of different three-dimensional imaging systems [25, 26]. According to our results, a mild-to-moderate upper eyelid sulcus deepening could be corrected with one or two injections of SVF gel. Additionally, other comparative studies have reported significantly lower reoperation rates and significantly higher patient satisfaction levels when SVF gel was used instead of Nanofat combined with high-density fat [27]. Zhou et al. applied a periumbilical adipose graft for ROOF augmentation to correct the upper eyelid sulcus deepening and reported fat survival rates of 60–80% [6]; however, this technique is not suitable for all patients because of the potential for more trauma and a relatively longer recovery time. On the basis of the results

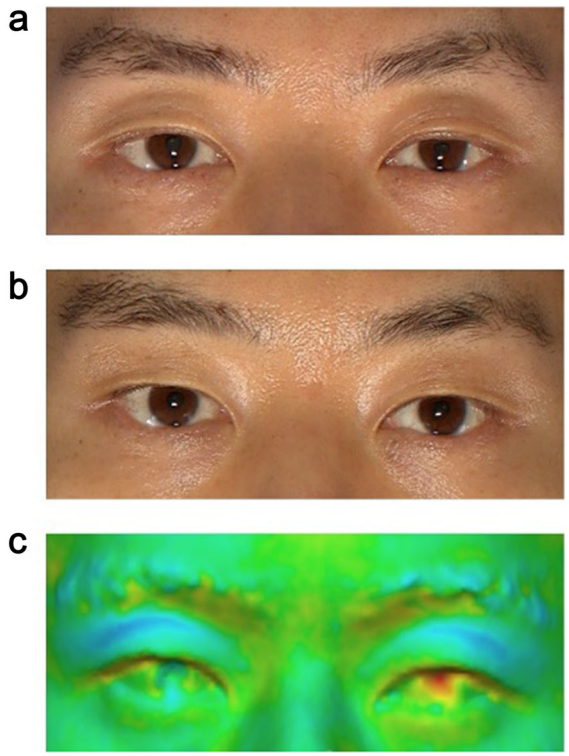

Fig. 7 Three-dimensional comparison of case 1. Surface map acquired by the VECTRA XT imaging system **a** preoperatively and **b** postoperatively. **c** Analysis of the volume difference in the upper eyelid sulcus using the two surface maps. The blue region shows the increase in volume postoperatively

of our study and those of analogical studies, the retention rate of SVF gel grafted to the periorbital area is comparatively stable and the rate of reoperation (12.9%) is acceptable [20, 27, 28].

During our study, the effective survival volume was used to assess the fat survival rate, which is similar to the augmentation rate (final volume augmented/initial recipient site volume) [29]. The VECTRA® 3D imaging system (Canfield Scientific Inc.), which is used worldwide, is mainly used to assess mammaplasty results in the field of plastic and reconstructive surgery [30–34]. Limited reports have addressed the application of this particular system for the evaluation of facial aesthetic surgery results, especially in the periorbital area [35, 36]. Our study indicated that the VECTRA® 3D imaging system could be used to evaluate the volume change in the upper eyelid. Furthermore, the VECTRA® 3D imaging system is useful for not only assessing facial aesthetic surgery results but also calculating the effective survival volume. Using the VECTRA® 3D imaging system, surgeons can estimate the appropriate volume for precise augmentation of different facial sites. In the future, by performing comparisons of the preoperative and postoperative images, surgeons may be able to design the simulated postoperative appearance in advance to calculate the initial site volume and determine the final augmented volume.

The choice of the plane for upper sulcus filling is controversial. Whether the ROOF layer or ocular anterior septum is better for fat grafting has been debated. The ROOF is a fibrotic fat pad between the orbicularis oculi muscle and the orbital septum that further extends to the brow and forehead [9–11]. We chose the ROOF layer for fat grafting during our study. Compared to the ocular anterior septum, the ROOF provides a continuous plane; therefore, the injected filler can spread more evenly [8, 37]. As fat grafting is a blind procedure, injection into a deeper plane such as ocular anterior septum may increase the incidence of iatrogenic ptosis due to damage to levator aponeurosis [8].

However, fat grafting the ROOF layer has certain limitations. The anatomical thickness of the ROOF varies in each person [38]. For patients with thinner ROOF, fat grafting with large amounts of unemulsified fat may be hazardous, resulting in fat necrosis or nodule formation.

The skin of the periorbital region is the thinnest in the body [7]. Therefore, to perform accurate and precise injections in this area, finer fat derivatives are required. SVF gel comprises smaller adipocytes compared to those in Coleman fat; therefore, it is suitable for delicate grafting and can prevent an uneven appearance [20, 22]. Moreover, SVF gel has higher resistance than Coleman fat and Nanofat; therefore, it is less likely to dissipate during eyelid movement [22]. Research has revealed that processing of SVF gel may eliminate most of the undesired

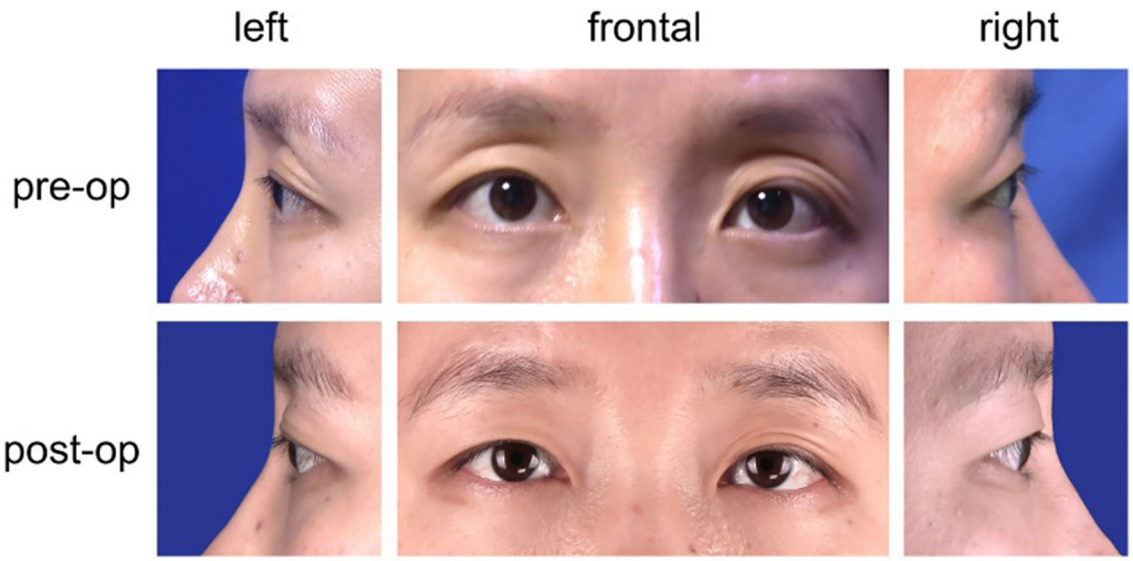

Fig. 8 A 35-year-old woman with a moderate left eyelid sulcus and mild right eyelid sulcus. We injected 1.5 mL of stromal vascular fraction (SVF) gel in the left sulcus and 1.2 mL of SVF gel in the right sulcus. The postoperative photos were obtained at 1 year. Left column, left side view; middle column, frontal side view; right column, right side view

components including incomplete adipocytes and oil droplets, thus reducing the risks of inflammation and fibrosis after fat grafting [19, 22, 26]. Yao et al. performed histologic evaluations of the long-term follow-up of SVF gel infraorbital injection and observed normal adipose tissue structures with less oil cysts, fibrosis, or calcification [20]. Similarly, during our follow-up, no long-term complications, such as infection, necrosis, and calcification, were observed. Cumulatively, our results suggest that SVF gel is an ideal filling material for the treatment of upper eyelid sulcus deepening.

On the basis of our experience, for patients with severe laxity of the eyelid skin, filling the upper eyelid will inflate the area and extend the frizzled skin. Consequently, few patients presented with hooded eyes postoperatively, and in these cases, their eyelashes were slightly covered by their upper eyelids compared to preoperation observations, especially in patients with monolids. Therefore, blepharoplasty was a better suggestion for elderly patients with severe depression and laxity.

This study had several limitations. Although we observed a stable overall survival rate and no obvious complications, our sample size was small, and the standard follow-up period of 1 year was limited. Moreover, only palpation was used to detect and assess complications such as fat fibrosis and nodules. Imaging modalities such as magnetic resonance imaging and ultrasound were not used, thus weakening the evidence level of the complication rate. Finally, there were some sampling biases in this study. There were more women than men in this study; this could have occurred because men in China are not as concerned about their physical appearance and attractiveness. Additionally, the ages of the patients were similar because we only enrolled patients with mild and moderate upper eyelid sulci. This pilot study was performed to confirm the clinical efficacy of SVF gel. However, future randomized controlled trials are warranted to compare its clinical efficacy with that of other filler materials.

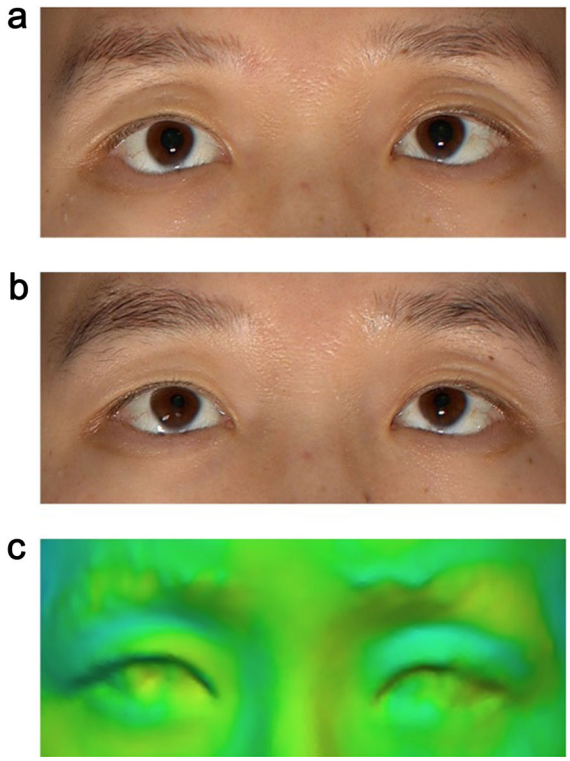

Fig. 9 Three-dimensional comparison of case 2. Surface map acquired by the VECTRA XT imaging system **a** preoperatively and **b** postoperatively. **c** Analysis of the difference in the volume of the upper eyelid sulcus using the two surface maps. The blue region shows the volume increase postoperatively

CONCLUSION

SVF gel is safe and effective for the treatment of upper eyelid sulcus deepening. Its use resulted in satisfactory clinical outcomes, a satisfactory effective survival volume, and no obvious complications.

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Data Availability. Data sharing is not applicable to this article because no datasets were generated or analyzed during the current study.

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