



# Correction of Upper-Eyelid Depression Through Retro-Orbicularis Oculi Fat (ROOF) Augmentation Using Periumbilical Adipose Graft

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## Abstract

**Objective** The authors sought to determine the efficacy of periumbilical fat block grafting to the orbital retro-orbicularis oculi fat (ROOF) layer to correct sunken-upper eyelids in Asians.

**Methods** All patients complained about upper-eyelid hollowness and a variety of deformities. Invasive double-eyelid procedures were performed, and periumbilical fat blocks were grafted for these patients. The core procedure of this approach was to make a separation between the orbicularis oculi muscle and septum to expose the retro-orbicularis oculi fat (ROOF) and fixate the fat grafts to the desired region of ROOF.

**Results** From February 2018 to October 2019, the novel technique was performed on 38 Chinese patients (76 eyes) in our department. After follow-up of 6–15 months, 35 patients (92%) showed satisfactory aesthetic results with approximately 20–40% fat absorption rate. No cases required a second procedure. Periumbilical scars remained hidden within the umbilicus area.

**Conclusions** Periumbilical fat grafting in the ROOF of the sunken upper eyelid can both fill the depression and help correct over-wide double eyelid.

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**Keywords** Sunken upper eyelid · ROOF (retro-orbicularis oculi fat) · Periumbilical fat grafting · Upper-eyelid depression · OOM (orbicularis oculi muscle)

## Introduction

Upper eyelid depression refers to the state which the upper eyelid appears in different degrees of hollowness between the upper tarsus and the superior orbital margin. Park S has classified the superior sulcus deformity into four stages: Grade 1 a sunken depth of 0.5 cm or less, Grade 2 a sunken depth ranging from 0.5 to 1 cm, Grade 3 a sunken depth of 1 cm or more, and Grade 4 refers to grade 3 accompanied by blepharoptosis [1]. Lipoatrophy and volume loss are now recognized as significant components of upper eyelid depression [2, 3]. Unlike occidentals, Chinese upper eyelid depression is usually accompanied by multiple eyelids and even blepharoptosis, which makes an individual appear fatigued and aged. Currently, diverse treatments are applied to correct the sunken eyelids including fat transposition, autologous fat grafting, and hyaluronic acid filling [4]. However, for the cases with massive loss of volume or Grade 3–4 superior sulcus deformity, fat transposition is not enough to solve those problems. Hyaluronic acid treatment might have a niche for less severe cases but

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require repeated procedures. Autologous fat grafting has gained increased acceptance in the periorbital area since its description firstly proposed by Coleman in 1995 [5], but lipofilling in the periorbital area has been reported with varied complications including absorption, fat necrosis, and risk of vascular embolization with visual loss or cerebral infarct [6, 7]. Due to the complexity of the upper eyelid structure, different filling layers are assumed to influence the survival rate of the fat grafts. Based on the available data from our practice, it confirms that the fat compartment between the orbicularis oculi muscle and the orbital septum is probably the most suitable region for augmentation. Besides, the excised adipose tissue is believed to be a functional filler for the sunken eyelid.

## Methods

A total of 38 patients (76 eyes) underwent the technique between February 2018 and October 2019. The hollowness was primary in 27 patients and secondary to blepharoplasty in nine patients. Eleven of them were accompanied by over-wide double eyelids. Four of them were accompanied by mild blepharoptosis. The three men and 35 women in the study ranged in age from 25 to 58 years old. For each patient, 6–15 months (average, 8.6 months) of follow-up evaluation was regularly carried out. The results of peri-umbilical fat grafting were evaluated by preoperative and postoperative photograph comparison, detailed clinical evaluation, and overall patient satisfaction assessment. All patients had signed informed consent before the operation.

## Surgical Technique

### Dual Space Dissection of Upper Eyelid

The desired filling area and skin incision were marked prior to the surgery. The operation was performed under local anesthesia with 2% lidocaine containing 1:100,000 epinephrine. Despite the fact that the details of the upper blepharoplasty were well known, a few points of this technique were still worth noticing. Skin, orbicularis oculi muscle, and retro-orbicularis oculi fat (ROOF) were incised until the septum was seen. Most patients required dual space dissection: pre-septal and post-septal dissection.

For those with over-wide double eyelids and multi-fold eyelid deformity, adequate separation of the post-septal space was essential to achieve an optimal result. Adhesion fibers around the fat pad or scar tissues between the septum and the levator aponeurosis were released; then, orbital fat was freed and repositioned to the caudal part of the levator aponeurosis with 7–0 nylon sutures. If blepharoptosis

repair was needed, the surgeon performed it with the levator advancement or a combined levator and Muller muscle advancement procedure.

The second plane was made between the orbicularis oculi muscle (OOM) and septum to expose the ROOF by a sharp dissection with ophthalmic scissors (Figs. 1, 2). Caution must be exercised to ensure adequate pocket dissection in the pre-septal space, especially on the upper portion of the fibrofatty compartment with abundant blood supply. Usually, this space was easy to separate with less bleeding.

### Donor Site

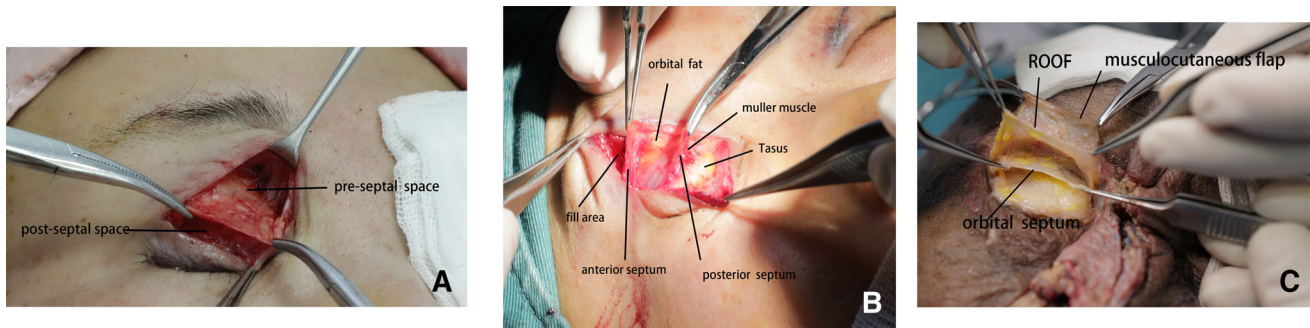
After completion of the bilateral eyelid dissection, attention was turned to the donor site. Local anesthesia was injected to the periumbilical area. A 10 mm incision was made at the umbilical fossa. Sharp dissection with ophthalmic scissors was performed to obtain a piece of peri-umbilical fat of the desired volume (Fig. 3). Then, the harvested tissues were soaked in 0.9% saline and the donor skin was closed after proper hemostasis.

### Graft Placement

After exposure to the ROOF, the periumbilical fat grafts were then cut and shaped to accommodate the receptor space. Normally, the fat grafts were preferably cut into slices, which could improve their survival rate (Fig. 4). While the assistant held the septum to expose the pocket, the surgeon sutured the fat grafts to the ROOF at the medial, central, and lateral of the pre-septal space (Fig. 5). The patients were then asked to open their eyes to compare the initial results. Usually, we made a 20–25% overcorrection. If the results were satisfactory, we closed the pre-septal space by suturing the distal edge of the anterior septum to the OOM with 7–0 nylon sutures. Finally, skin closure was done with a 7–0 nylon suture in an interrupted suture manner.

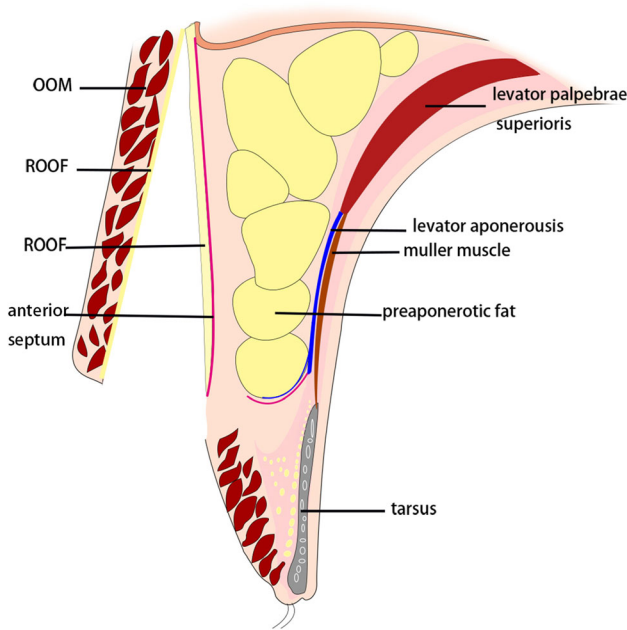
## Results

Thirty-eight patients were followed up for 6 to 15 months, with an average of 8.6 months. The mean age was 42 (range 25–58), and 3/38 patients were male. In 11 patients with over-wide double eyelids, the widths of their double eyelids have been narrowed to some extent. Four cases with mild blepharoptosis were corrected. Thirty-five patients (92%) had satisfactory aesthetic results (Figs. 6, 7, 8, and 9). The fat absorption rate was 20–40%. During the whole follow-up period, we observed that the fat absorption time was concentrated at 1–3 months and then stayed



**Fig.1** Dual space dissection of upper eyelid: The first plane (post-septal space) was made between the septum and the levator aponeurosis. The second plane (pre-septal space) was made between

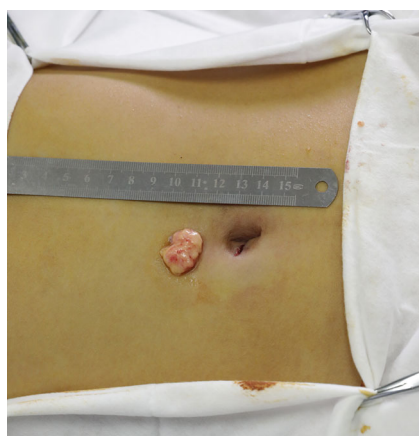
the orbicularis oculi muscle (OOM) and septum to expose the ROOF. **A and B** dual space in vivo. **C** dual space in cadavers



**Fig. 2** Sagittal schematic diagram of the exposure to the retro-orbicularis oculi fat (ROOF)



**Fig. 4** The fat grafts were preferably cut into sheets, and the grafts can be as large or small as needed for every patient



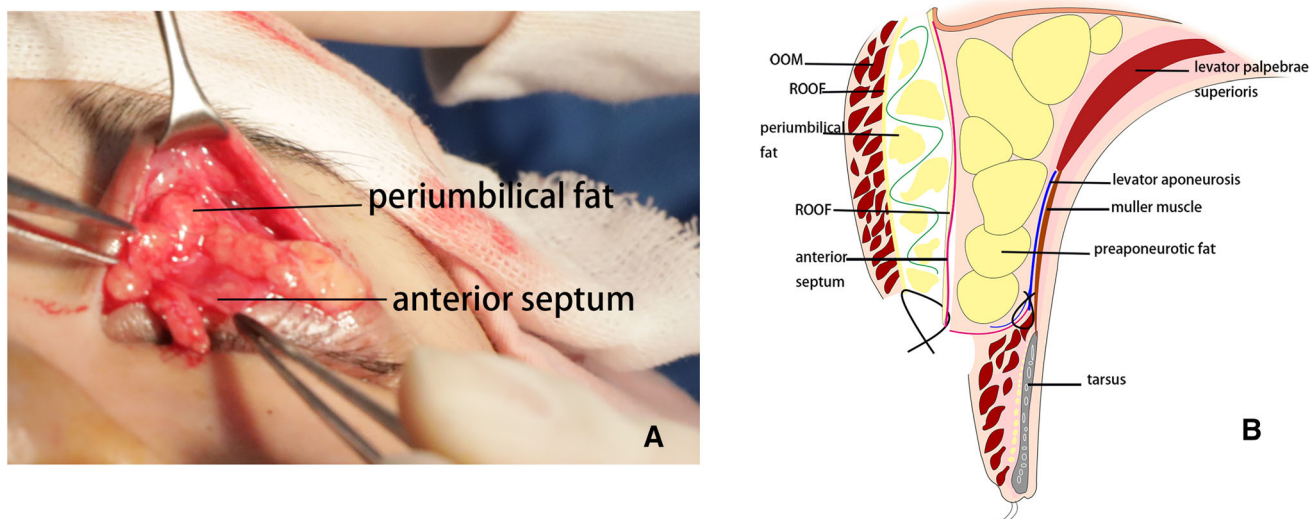
**Fig. 3** Periumbilical fat graft obtained through a 10 mm periumbilical incision

stable in the following period. No cases required a second procedure. There were no significant complications such as contour irregularity, hematoma, and infection. Minor complications such as slight capacity asymmetry have occurred early in three patients, which recovered spontaneously within 3 months.

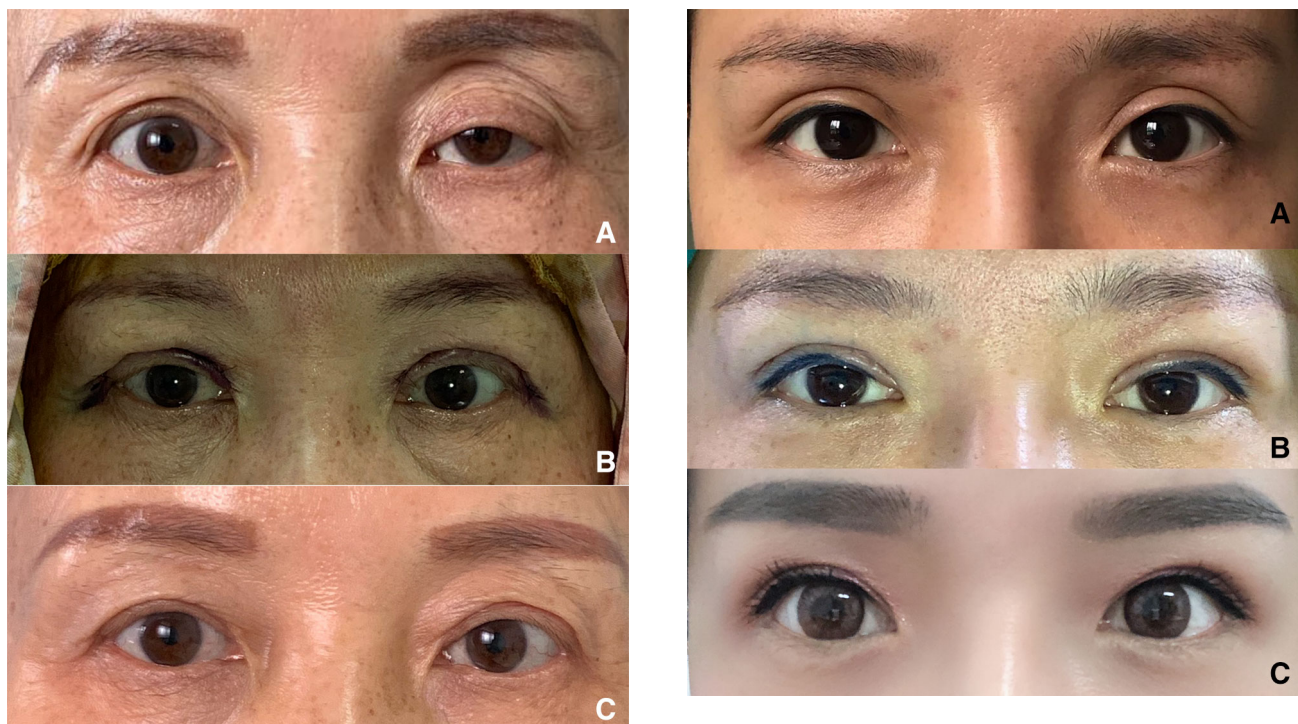
The periumbilical surgical area did not generate any kind of symptoms during the postoperative period, and all scars remained hidden within the umbilicus area.

**Discussion**

The upper eyelids are composed of anterior lamella and posterior lamella separated by the orbital septum. The anterior lamella is formed by the skin and underlying orbicularis oculi muscle. The orbital septum, originating from a band of thickened periosteum at the orbital rim (the arcus marginalis), separates both lamellae and is often referred to as the middle lamella. The posterior lamella is composed of the tarsal plate, eyelid retractors, and conjunctiva. In the upper eyelid, there are two medial fat pads communicating directly with retro-ocular fat and one long



**Fig. 5** **A** Periumbilical excised adipose grafts applied to the retro-orbicularis orbital fat (ROOF). **B** This is a diagrammatic drawing of the sagittal position. The ROOF layer was filled with periumbilical fat blocks and was closed with a 7-0 nylon suture in an interrupted suture manner



**Fig. 6** **A** 45-year-old woman with bilateral sunken eyelids and unilateral ptosis. **A** Preoperative photograph. **B** Immediately after operation. **C** One year postoperatively

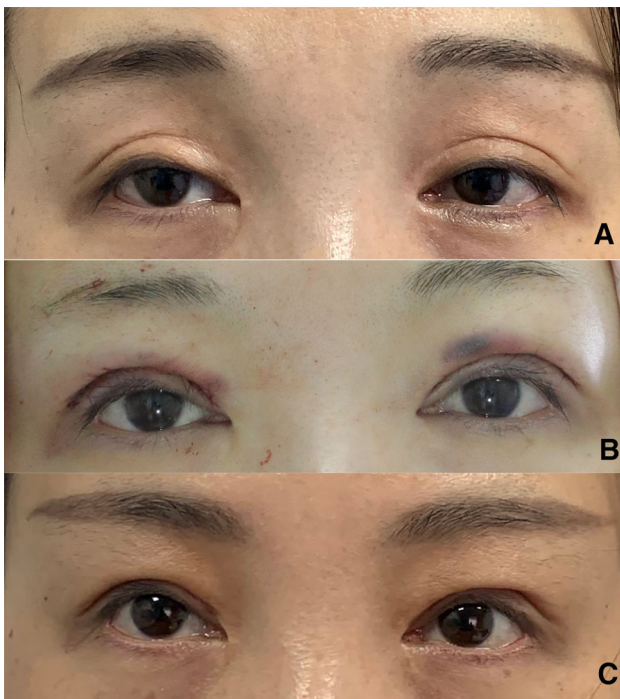
**Fig. 7** **A** 30-year-old woman with bilateral sunken eyelids of different severity. **A** Preoperative photograph. **B** Immediately after operation **C** Six months postoperatively

lateral fat pad situated immediately anterior to the levator palpebrae superioris in the supraorbital sulcus. The ROOF is located in the upper eyelid deep to the orbicularis oculi and above the orbital fat pads in a separate layer. In theory, applying the fat grafts to any layer of the upper eyelid can correct the depression. However, given the thin nature of the upper eyelid skin, the subcutaneous fat filling may

increase the risk of contour irregularity [8]. Yoon et al. reported that filling the pre-aponeurosis space with the grafts could yield satisfactory results [9]. However, the orbital fat is located in the pre-aponeurosis space; once the fat grafts become necrotic or sclerotic, fibrous adhesion between the fat grafts and levator aponeurosis may appear, which will result in iatrogenic ptosis. We believe that the pre-aponeurosis space is important for the movement of



**Fig. 8** A 41-year-old woman with bilateral severe sunken eyelids. **A** Preoperative photograph. **B** Immediately after operation **C** Eight months postoperatively, showing full eyelid, normal eyelid margin, and symmetrical eyes



**Fig. 9** A 38-year-old woman with over-wide upper eyelids. **A** Preoperative photograph. **B** Immediately after operation. **C** One month postoperatively

levator muscle, so that it should be filled with buccal fat or pouch fat from the lower eyelid, which is histologically identical to the pre-aponeurotic fat, rather than exogenous fat derived from other parts of the body.

The ROOF is located between the orbicularis muscle and the septum, which acts as a cushion to reduce the tissue friction of muscle movement. According to SangKeun Park's research, the ROOF is located just above the sunken area of the upper eyelid [1]. And Hwang et al. reported that the ROOF site is a depressed area that is suitable for grafting [10]. Our previous research indicated that whether ROOF tissue is too thick or too thin will result in an aged appearance [11]. During hypertrophy, the lateral side of the upper eyelid is heavy and promotes upper eyelid skin sagging. When ROOF tissue is excessively removed or poorly developed, the upper eyelid is sunken. Therefore, to achieve a younger appearance of the upper eyelid, the volume of ROOF should be appropriate. Moreover, the fat compartment between the orbicularis oculi muscle and the orbital septum is the most suitable region for augmentation.

Although the agreement has been reached on the transplantation of particulate fat to the ROOF layer, some problems still exist [1, 8]. Firstly, the ROOF layer is very thin, so it is difficult to inject the aspirated fat into this layer accurately, and sometimes the needle might reach the pre-aponeurosis and cause damage. Furthermore, for those with Grade 3–4 superior sulcus deformity, the ROOF layer is thinner, so it is more difficult for the surgeon to inject the aspirated fat into the ROOF. And usually a single injection is not enough which may require repeated treatments. Secondly, ROOF mainly consists of fibrous adipose tissue rather than adipose tissue. Unlike the aspirated fat, the periumbilical fat grafts in this technique are excised adipose tissues containing connective tissue with medium and small vascular vessels, which are very similar to the ROOF histologically.[12, 13] Third, reports suggested that there is approximately 50–100% volume loss with fat injection [14]. Finally, the most feared complication of fat injection is fat embolism and stroke or blindness, with several cases reports in the literature, while an open approach can avoid such risks [15, 16]. Therefore, the periumbilical fat blocks were considered as the more suitable filler for the sunken eyelid.

Maybe there are some doubts about the survival rate of periumbilical fat blocks, as previous studies reported that the fat blocks were easy to be absorbed and became oily cysts or nodules, but the periumbilical fat blocks survived finely in the periorbital area in our technique. We speculated that it was the abundant blood supply around the orbital area that provided nutrition for the grafts. Furthermore, the fat grafts were preferably cut into sheets, which was also beneficial for survival.

To sum up, during this procedure, the ROOF layer was clearly separated, and this method could intuitively control the filling capacity, which was different from lipofilling in ROOF. The most significant advantage is that the anterior septum is used as a natural barrier preventing fat grafts from damaging the levator aponeurosis system.

There were still some limitations in our research. The number of cases in this article was insufficient, and the data on the longevity of results were primarily subjective and photography based. Thus, it is necessary to accomplish further objective measure of the degree of volume enhancement.

## Conclusion

Periumbilical fat grafting in retro-orbicularis oculi fat (ROOF) layer could be used alone or in conjunction with other procedures such as blepharoplasty technique as part of the treatment of sunken upper eyelids, especially the severe eyelid depression. It is a safe and effective method that can achieve favorable long-term results and improve upper-eyelid contour.

## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical Standard** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed Consent** For this type of study, informed consent is not required, but patients provided informed consent before the operation.

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