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OCULOPLASTICS AND ORBIT

The reconstruction of a contracted eye socket using a post-auricular full-thickness skin graft

Yi Hsuan Wei · Shu Lang Liao

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Abstract
Purpose To report the efficacy of a full-thickness skin graft (FTSG) for the reconstruction of a contracted eye socket.
Design A retrospective, non-comparative, interventional case series.
Methods This was a retrospective review of patients with a contracted eye socket who underwent socket reconstruction using a post-auricular FTSG from 2001 to 2011 at the National Taiwan University Hospital. The postoperative results including prosthetic fitting, the cosmetic result, and eyelid function were assessed.
Results There were 11 male and 15 female patients, with a mean age of 52.3±15.6 years (range 21 to 76). The duration of the socket contracture varied from three months to three years (average 7.4±8.1 months). The severity of the socket contracture ranged from grade 2 to grade 4, based on Tawfik's classification. The mean follow-up time was 35.7±9.6 months. After socket reconstruction, using a post-auricular FTSG, 96 % of the cases (25 of 26) demonstrated a successful prosthetic fitting and a satisfactory cosmetic outcome. Both good eyelid function and a stable fornix depth were maintained during the follow-up time. One case received a second socket reconstruction three months after the first operation, using a FTSG, because of an inadequate lateral fornix. The final result was satisfactory. There were no serious complications, but a granuloma formed in one case, and there was prolonged discharge in one case.
Conclusions The reconstruction of a contracted eye socket using a post-auricular FTSG is an effective method with a high success rate, which causes less discomfort to donor sites and results in few complications.

Keywords Socket reconstruction · Full-thickness skin graft · Prosthesis · Socket contracture

Y. H. Wei · S. L. Liao (✉)
Department of Ophthalmology, National Taiwan University Hospital, 7, Chung Shan South Rd, Taipei, Taiwan
e-mail: liaosl89@ntu.edu.tw

S. L. Liao
School of Medicine, National Taiwan University, Taipei, Taiwan

Introduction

Contracture of the eye socket can lead to difficulty in prosthetic fitting and cosmetic problems for anophthalmic patients, or patients with an atrophic globe. It also becomes a source of chronic discharge and irritation. Contracture of the eye socket is caused by a foreshortening of the conjunctival fornices and/or a loss of volume in the orbital socket. Various surgical techniques have evolved to solve this problem [1]. Several grafting materials have been used in the management of foreshortened conjunctival fornices, including buccal mucosa grafts [2–4], hard palate mucosal grafts [5–7], skin grafts [8, 9], amniotic membrane grafts [10, 11], polytetrafluoroethylene sheets [12, 13], and custom-designed conformers [14–16]. Autologous dermis fat [17] and a free forearm flap [18] have also been used to augment the orbital volume.

In most contracted eye sockets, the problem of prosthetic fitting can be solved by reinstating deep and stable conjunctival fornices. Mucous membrane transplantation remains the most widely used method for the treatment of the foreshortened conjunctival fornices. However, poor rigidity of the mucosa membrane and postoperative mucosal contracture can increase the rate of recurrence [6]. In addition, it is difficult to harvest a large amount of mucosal grafts and hard palate grafts for severe fornix contracture. If too large a graft is harvested, donor site discomfort and morbidity is noted for mucosal grafts and hard palate grafts [19, 20].An amniotic membrane graft also lacks rigidity and the rate of recurrence

has been found to be as much as 20 % in a previous report [10]. A full-thickness skin graft (FTSG) is easy to harvest in large amounts, without complication. It is suitable for the treatment of a severely contracted eye socket. In this study, a post-auricular full-thickness skin graft (FTSG) is used to reconstruct a contracted eye socket. The authors present their experiences over the past ten years and describe the results and benefits of this method.

Materials and methods

Patients and clinical evaluation

A retrospective medical record review was performed for all patients who underwent socket reconstruction, using a post-auricular FTSG, for a contracted eye socket, in the National Taiwan University Hospital from 2001 to 2011. The Ethics Committee of National Taiwan University Hospital approved the protocol of this study. Informed consent was obtained from each patient or family members/guardians of those enrolled in the study. All patients were unable to be fitted with or unable to retain an ocular prosthetic device before the surgery. Their contracted sockets and fornices had been stable for at least three months before reconstruction. All operations were performed by a single oculoplastic surgeon (S.L. Liao). The data collected included the patient's age, gender, diagnosis, the severity of the socket contracture, complications and post-operative follow-up time. The severity of the socket contracture was assessed according to an updated classification by Tawfik, et al. [1]. The socket contracture was classified into four categories, as follows: Grade 1: Minimal or no actual contraction. Patients usually complain of an inability to retain the prosthesis for a long time. Grade 2: Mild contracture of the inferior and/or the superior fornix. Patients either complain of an inability to wear the prosthesis or may complain of a cosmetic disfigurement, due to rolling-in of the upper and lower eyelid margins. Grade 3: More advanced scarring than grade 2 and cicatrization, generally involving the entire upper and lower fornices. Wearing the prosthesis is impossible. Grade 4: Severe phimosis of the palpebral fissure, both vertically and horizontally. Recurrent cases and irradiated sockets are also included in this category.

The postoperative results, including prosthetic fitting, the cosmetic result and eyelid function, were recorded. The prosthetic fitting was assessed as successful, acceptable, or poor. A fitting was deemed to be successful when the prosthesis fit appropriately between the superior and inferior fornices, without rotation or slipping. The superior and inferior fornices were deep to maintain the prosthesis. A fitting was deemed to be acceptable if the prosthesis fitted without extrusion. However, the prosthesis may tilt or rotate slightly while blinking. The fornix was mildly shallow. A fitting was deemed to be poor if there was a shallow fornix, with a depth that was inadequate to maintain the prosthesis. The cosmetic outcome was assessed as satisfactory, acceptable, or unsatisfactory, based on the results of a questionnaire that was given to patients at six months after the operation. The eyelid function was accessed according to any entropion, ectropion, or ptosis after socket reconstruction. The eyelid function was defined as good for eyelids without entropion, ectropion, or ptosis. Any postoperative recurrences or related complications were also recorded. The patients were given follow up examinations at one week, three weeks, six weeks, three months, six months and every six months after the operation.

Surgical technique

The surgeries were performed under general anesthesia and local anesthesia, using lidocaine 2 % with epinephrine 1:100,000. The contracted fornix was exposed using a 4–0 silk traction suture. The conjunctiva overlying the inferior forniceal area was dissected down to the orbital rim and fibrotic scar tissues were completely released. The tension-free area to be covered with the graft was measured using a piece of paper (Fig. 1a). A FTSG of the same size as the paper was then harvested from the post-auricular area. The graft was about 2×4 cm to 3×6.5 cm and had a fusiform shape (Fig. 1b). The wound at the donor site was closed, using 4–0 Dexon sutures, and packed with iodine-gauze. The FTSG was trimmed to remove the subcutaneous fat and clotted blood. The epithelium of the FTSG was not removed. The FTSG was then placed over the exposed forniceal area, with the skin-side upward. It was anchored to the dissected conjunctival margin using 5–0 Dexon interrupted sutures (Fig. 1c). A strip of size 10 French Foley catheter, 3 cm in length, was used as the fornix stent to splint the FTSG in place (Fig. 1d). Two 2–0 Prolene mattress sutures were passed through the Foley strip and the underlying FTSG, and they were anchored to the periosteum for fornix fixation (Fig. 2a). The fixation needle was then passed through the skin and the sutures were tied over two rubber bands (Fig. 2b–c). An appropriately sized plastic conformer was placed on the ocular surface to maintain the extension of the fornix (Fig. 2d). A temporary tarsorrhaphy was performed using a 4–0 silk suture. For cases that involved reconstruction of the upper fornix, a similar procedure was performed. However, dissection between the conjunctiva and levator complex was performed carefully, in order to avoid any injury to the levator complex. The tarsorrhaphy suture was removed three weeks after the operation. The conformer and Foley strip were removed at six weeks. The patients were fitted with ocular prosthetic devices two months after the operation.

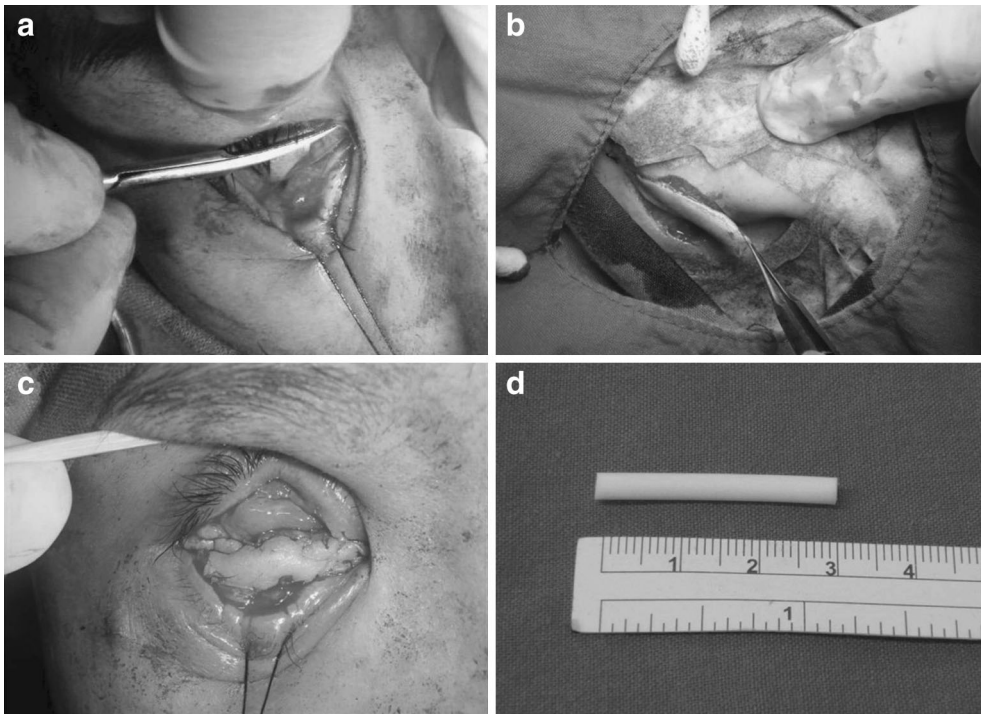

Fig. 1 Surgical technique of socket reconstruction using full-thickness skin graft (FTSG). **a** Expose the conjunctival fornix and release the fibrotic scar tissues. **b** Harvest a FTSG from the post-auricular area. **c** Anchor the FTSG to the conjunctival margin. **d** Prepare a strip of size 10 French Foley catheter

Results

Socket reconstruction using a post-auricular FTSG was performed on 26 patients (11 males and 15 females) over a period of ten years. The average age at the time of surgery was 52.3± 15.6 years (range 21 to 76). The major cause of blindness in 19 cases (73 %) was trauma. Other causes of blindness included neoplasm in two cases (one melanoma and one lymphoma), infection in two cases, uveitis in one case, a congenital anomaly in one case, and a chemical burn in one case. Nine patients (35 %) had received enucleation and twelve (46 %) had received evisceration. In five cases (19 %), the

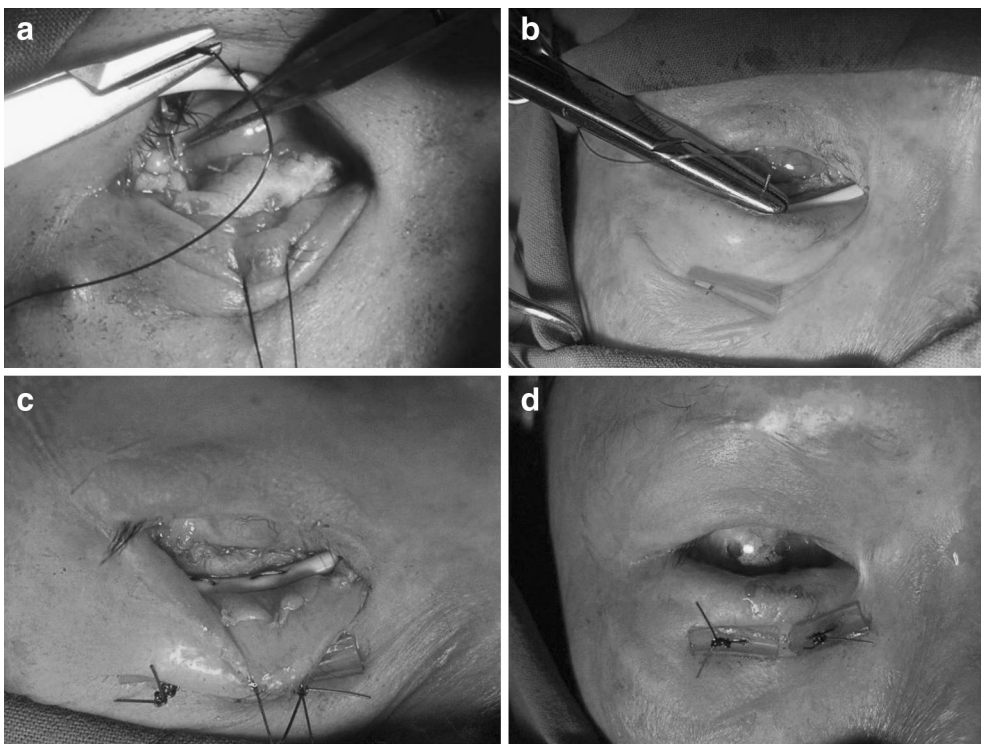

Fig. 2 Surgical technique of socket reconstruction using FTSG (cont'd). **a** Fix the Foley strip to the FTSG and anchor to the periostium of the orbital rim with 2–0 prolene mattress sutures. **b** External fixation over the rubber band. **c** Final position of the FTSG and the Foley strip. **d** Place the plastic conformer

globe remained atrophic. Eighteen-mm or 20-mm orbital silicone implants or bioceramic implants (FCI, Moulineaus, France) were used in the cases with enucleation and evisceration. The time between the onset of socket contracture and the time of surgical reconstruction was 7.4±8.1 months (range 3 to 36). The classification of the socket contracture was grade 2 in six cases (23 %), grade 3 in 18 cases (69 %), and grade 4 in two cases (8 %). The two cases with a grade 4 socket contracture were recurrent cases that had received socket reconstruction with a mucosal graft. They were referred to the hospital because there was recurrent contracture of the eye sockets. The duration between the previous operations was two years in both cases. Twenty lower fornices (77 %), one upper fornix (4 %) and in five cases of both upper and lower fornices (19 %) were reconstructed. The average postoperative follow-up time was 35.7±9.6 months (range 24 to 51, median 30).

At six months after the operation, the prosthetic fitting was successful in 25 patients (96 %) and acceptable in one case (4 %) due to an inadequate lateral lower fornix. The cosmetic outcome was satisfactory in the 25 patients with a successful prosthetic fitting. For the case with an inadequate lateral lower fornix, a second socket reconstruction using a FTSG was performed at three months after the first operation. The final results for prosthetic fitting and cosmetic outcome were successful and satisfactory. Over the average follow-up time of 36 months, the eye sockets remained adequate and stable, in terms of prosthetic fitting, in all cases (Figs. 3, 4, and 5). The eyelid function in all cases was good, with no entropion, ectropion, or ptosis. The postoperative complications included the formation of a granuloma in one case and prolonged discharge for six months in one case. Five patients (19 %) complained of a foul but tolerable smell in the first three months after the operation. For the case with prolonged discharge and foul smell, the symptoms were relieved by removing the discharge and by irrigating the fornices with normal saline two to four times a day in the initial three months to six months. The discharge and foul smell disappeared gradually three months to six months after surgery. Conjunctivalization of the FTSG was noted in all cases six to 12 months after implantation. There were no donor-site complications or cosmetic problems with the ear for any of the patients.

Discussion

Socket contracture can be caused by various processes, such as fibrosis from an initial injury, implant extrusion, chronic infection, irradiation, or failure to wear a prosthesis or conformer [4, 10]. The clinical outcomes of contracted eye sockets include extensive loss of the conjunctival surface, foreshortening of the conjunctival fornices, deep cicatrix formation, and orbital fat atrophy. To reconstruct a contracted socket successfully, a stable fornix of adequate depth is formed by increasing the surface area with grafting materials. Orbital implants are also necessary in cases where there is a loss of orbital volume. In this study, the principal problem for the patients was foreshortening of the conjunctival fornices, but not volume loss. A post-auricular FTSG was used as the grafting material to deepen the conjunctival fornices.

A variety of grafting materials have been used in the management of foreshortened conjunctival fornices. Each grafting material has advantages and disadvantages. Mucosal grafts can be harvested from the buccal mucosa, the nasal mucosa, the lips, the prepuce, the labia minora, the vagina, or the rectum [10]. The difficulties in obtaining a mucosal graft include the need for specialist consultation and discomfort at the donor sites [21]. Buccal mucous membrane is the most widely used mucosal graft because it is abundant and easily accessible. However, mucosal contracture and submucosal scar formation increase with the size of the buccal mucous membrane harvested [19]. In addition, mucosal grafts lack the rigidity that is required to maintain the fornix depth in cases with severe socket contracture [1]. Hard plate mucosal grafts are more rigid and resistant to contracture than mucosal grafts. However, recurrent socket contracture in 20 % of cases was reported in a previous study [5]. It is also sometimes difficult to obtain adequate graft material from the hard palate to reconstruct both the upper and the lower fornices [6]. Postoperative hemorrhage at the donor site is reported as a major complication [20]. The amniotic membrane is not a grafting material in the usual sense, but a scaffold for the growth of conjunctival stem cells to repopulate the surface. It can be used with no limitations in terms of tissue availability or a secondary wound. However, recurrent forniceal shortening is reported in 20 % of cases after socket reconstruction using an amniotic membrane graft [10, 11]. Other complications include suture abscess and multiple socket granulomas [11]. The quality of amniotic membrane varies with the preparation and storage procedure, but commercial amniotic membrane is expensive.

Polytetrafluoroethylene (e-PTFE) sheet has been used as an temporary graft in socket reconstruction, but there are complications with postoperative shrinkage [12]. Recently, Elner et al. [13] described a technique to deepen the foreshortened conjunctival fornices in 17 cases using a rigid nylon strip and an e-PTFE sheet. The e-PTFE sheet is used as a scaffold for conjunctival epithelialization. The rigid nylon strip, which anchors the sheet to the orbital rim, prevents wound contracture in the fornices. The complications included postoperative infection in two patients, pyogenic granulomas in three patients, and inadequate reconstruction in four patients with initial severe forniceal foreshortening.

This study used a post-auricular FTSG for socket reconstruction. There are several advantages to use a post-auricular

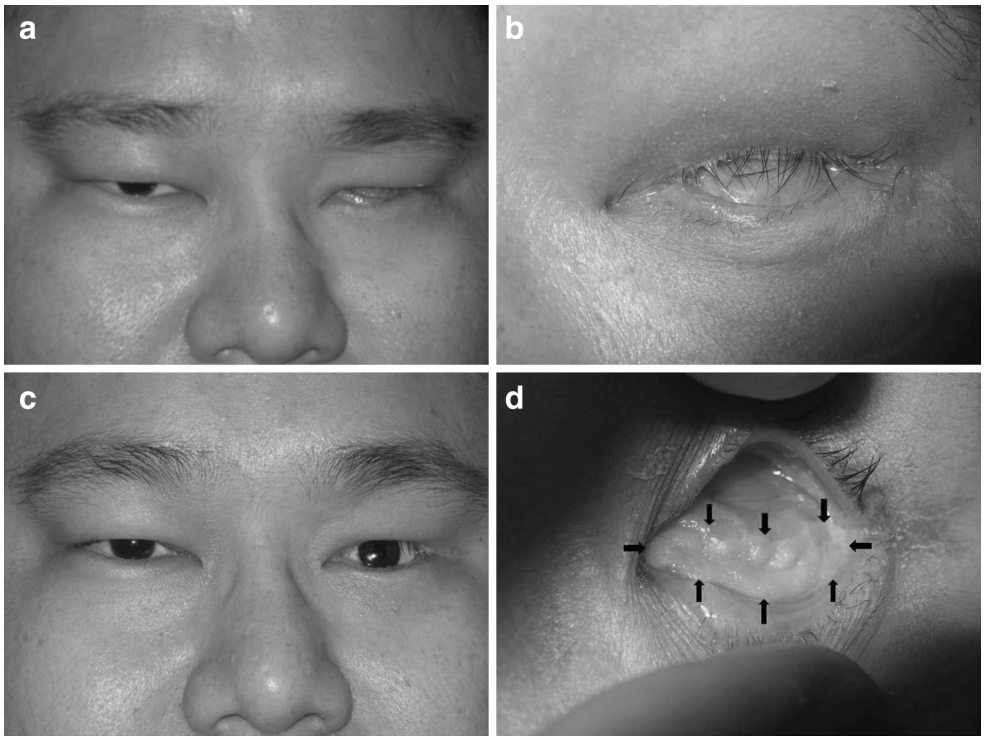

Fig. 3 A 29-year-old man who underwent left evisceration for uveitis-associated painful blind eye developed grade-2 socket contracture. **a** The patient was unable to wear an eye prosthesis before the operation. **b** The preoperative appearance of the eye socket showed shortening of the lower conjunctival fornix. **c** After socket reconstruction, using a post-auricular FTSG, the prosthesis was retained stably in the socket. **d** The appearance of the fornix at 12 months after the operation indicates an adequate and stable depth. The skin graft is marked with *arrows*

FTSG for socket reconstruction. Firstly, it is easy to harvest the graft and to manage the wound at the donor site. The operation time is shortened because less time is required to obtain the graft. Secondly, the bilateral post-auricular areas provide ample material for the graft. It can be used for both upper and lower forniceal reconstruction and in the recurrent cases where the graft had already been harvested from one side. Thirdly, there is minimal donor site morbidity and less obvious scarring which decreases postoperative discomfort to the patient. Lastly, the adequate rigidity and minimal postoperative shrinkage of FTSG render it more effective in stabilizing the fornices. In this study, the operation time ranged from

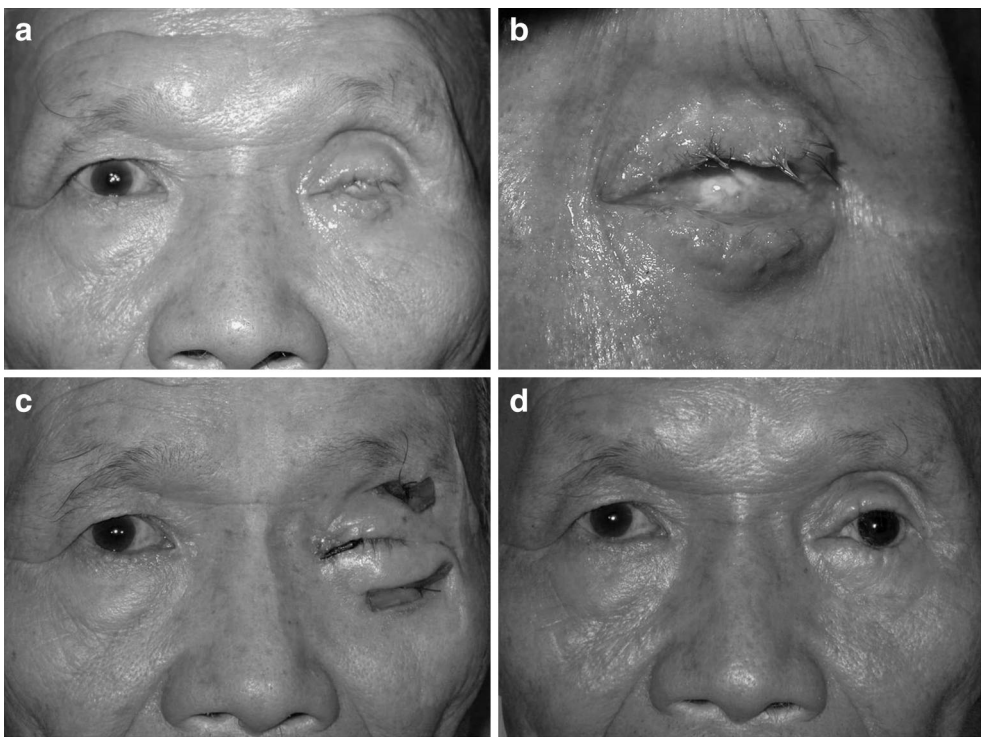

Fig. 4 A 76-year-old man who underwent left post-traumatic enucleation developed grade-3 socket contracture. **a** The appearance before socket reconstruction. **b** The upper and lower conjunctival fornices were both shortened. **c** The appearance at two weeks after socket reconstruction using a post-auricular FTSG in both upper and lower fornices. **d** The appearance at six months after the operation demonstrates a successful prosthetic fitting

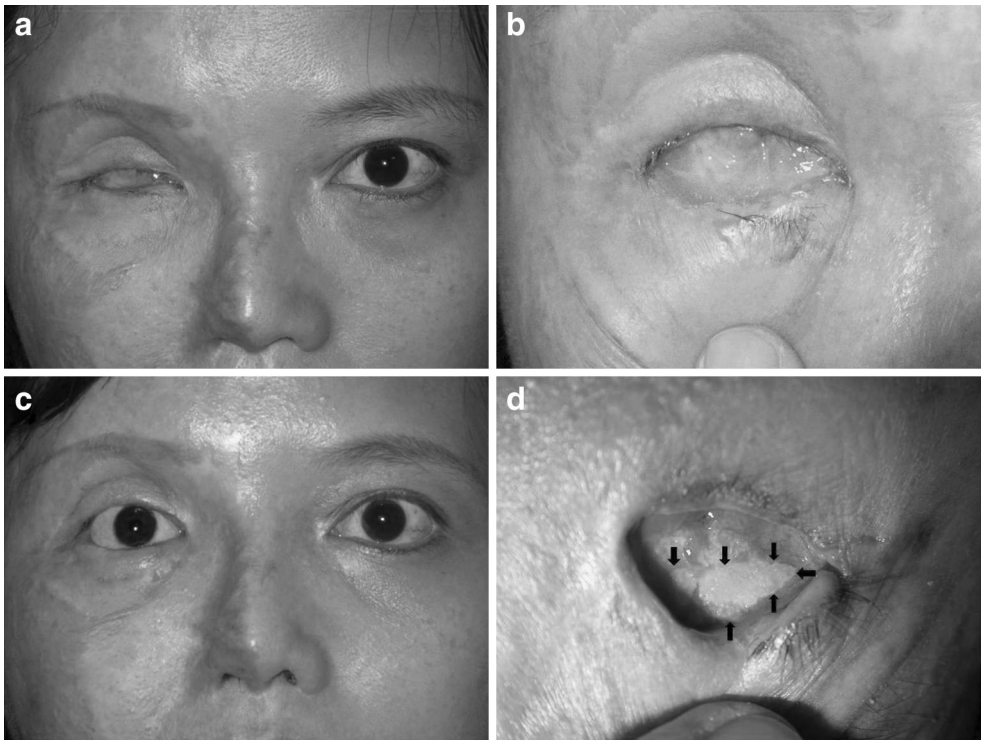

Fig. 5 A 60-year-old woman developed grade-3 socket contracture after a chemical burn. **a** The appearance before socket reconstruction. **b** The lower conjunctival fornix was shortened with severe symblepharon. **c** The appearance after socket reconstruction using a post-auricular FTSG demonstrates a successful prosthetic fitting. **d** The appearance of the fornix at 12 months after the operation shows the conjunctivalization of the FTSG and indicates an adequate and stable depth. The skin graft is marked with *arrows*

50 to 70 min and there was no difficulty in graft harvesting. All of the wounds at the donor sites healed well two weeks after the operation. No complications were noted at the donor sites, nor were there any cosmetic problems with the ears in this study. All of the reconstructed fornices remained deep and stable for the prosthetic fitting with no shrinkage of the FTSG.

There have been a few series studies of socket reconstruction using FTSG or split thickness skin grafts in the past ten years [8, 22]. In the comparative study by Abood et al. [8], thick split thickness skin grafts were used in 18 cases, while FTSGs from the groin or post-auricular region were used in eight cases. It was found that the FTSG tended to be complicated with partial graft loss due to inappropriate fixation. However, secondary contraction in the FTSG was shown to be less than that in the split thickness skin graft. In this study, the subcutaneous fat of the FTSG was completely removed to make the graft thinner for implantation. The splints of the Foley catheter strip and eye conformer also secured the graft well. Therefore, no graft loss due to inappropriate fixation was noted in this study.

In the method described, a strip of Foley catheter was used to splint the FTSG in place. The Foley strip anchoring the FTSG to the periosteum of the orbital rim meanwhile opposes the contractile forces caused by myofibroblasts proliferation. The action of myofibroblasts in the proliferative phase of wound healing causes wound contracture mostly during the first month after the operation [23]. Therefore, it is appropriate to remove the conformer and the Foley strip at six weeks after the operation. Fibroblast-associated wound contracture is the main cause of inadequate postoperative forniceal depth in this study. The prevention of graft contracture during the critical first postoperative month improves the long-term stability of the fornices.

Since the epithelium of the FTSG was not removed, the major disadvantage in using a post-auricular FTSG is the possible foul smell from sebaceous gland secretion and discharge due to desquamation after the surgery. In this study, the desquamation and sebaceous gland secretion diminish gradually after three months in most cases without special management for socket hygiene. However, for the case with prolonged discharge and the five cases with foul smell, the symptoms were relieved by removing the discharge and by irrigating the fornices with normal saline two to four times a day in the initial three to six months. Antibiotic eye drops were used in these cases to prevent infection. Fortunately, the foul smell and discharge disappeared gradually three months and six months after the surgery, respectively. Li et al. [15] designed a modified ocular conformer-drainage tube system for the patients who underwent socket reconstruction using a free skin graft. The device aids drainage of the secretion from the wound with tight tarsorrhaphy. The tight tarsorrhaphy was maintained for 12 weeks in order to prevent any extrusion of the conformer. In this study, the suture tarsorrhaphy was removed at three weeks after the operation, and no accumulation of the secretion or secretion-related infection was noted in the conjunctival sac.

In this study, 25 of the 26 patients (96 %) with contracted socket were successfully treated with socket reconstruction

using a post-auricular FTSG. Only one case required a second operation because of inadequate forniceal depth. All of the fornices remained deep and stable and had retained the prostheses appropriately after long-term follow-up (35.7± 9.6 months). No serious complications occurred at the donor or recipient sites. In conclusion, the reconstruction of a contracted eye socket with a post-auricular FTSG is an effective method with a high success rate, less discomfort to donor sites, and few complications. Despite the successful results of this study, further larger studies are required in order to compare the outcomes and complications of socket reconstruction using a post-auricular FTSG with those that use other autologous or alloplastic materials.

Conflict of interest The authors have declared that no competing interests exist.

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