Silicone Scaffold Support Using a Bilayer Dermal Regeneration Matrix Template for Correction of Primary or Recurrent Eyelid Retraction

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Purpose: To evaluate the efficacy and safety of a bilayer dermal regenerative matrix for primary or complex/recurrent eyelid retraction.

Methods: Retrospective review of patients undergoing eyelid retraction repair using the bilayer dermal regenerative matrix from 2005 to 2019. Nineteen eyelid surgeries from 15 patients were identified. Collected data included patient demographics, symptoms, preoperative/postoperative lower eyelid position, inferior scleral show, lagophthalmos, etiology of retraction, history of prior retraction surgeries, major/minor complications, and follow-up duration (minimum 6 months). Postoperative measurements were taken at a minimum of 1 week, 3–6 weeks, 2–4 months, and 6 months.

Results: Postoperatively, 90% of cases had good improvement of lower eyelid retraction (defined as 1 mm or less below the inferior limbus). Postoperative elevation of the lower eyelid ranged 1–3.5 mm compared with preoperative measurements. When used in the upper eyelid for conjunctival scarring, the implant improved the superior fornix depth. Complications were minimal and included transient conjunctival injection, eyelid edema, and foreign body sensation. No patients requested early removal of the silicone layer due to ocular pain.

Conclusions: The bilayer dermal regeneration matrix template may be considered a reasonable alternative to other spacers to reduce the vertical palpebral fissure and eyelid malposition in primary, complex, or recurrent cases. It also worked well for first-line correction of thyroid retraction, which tend to be more challenging due to globe proptosis. Suboptimal results may have occurred due to active cicatrizing conjunctival disease, or residual negative vector of the cheek and orbit. High cost may be a consideration, and the bilayer dermal regeneration matrix template was not studied directly against hard palate and other spacer materials.

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Lower eyelid retraction is a common eyelid malposition that is seen frequently in ophthalmic plastic surgery practices. It can be due to a variety of causes including thyroid eye disease, facial nerve palsy, and secondary to surgery, trauma, or other cicatrizing conditions. Retraction can be both cosmetically as well as functionally problematic and can significantly impact quality of life. There are numerous techniques described in the literature for surgical correction of eyelid retraction. Many methods employ a spacer graft inserted into the posterior or middle lamella of the eyelid, which provides structural support for the repair. A wide variety of graft materials have been used. Historically, most grafts were autologous and have included hard palate mucosa, cartilage (most commonly auricular cartilage), and dermis.[1–5] More recently, nonautologous materials, such as acellular dermal matrices have also been used.[1,3–9]

Although various acceptable spacers are available, there are no established guidelines on which material is most suitable for any particular etiology. Even with use of spacers, recurrence of retraction may occur and is particularly challenging. Revisions often lead to further fibrosis, retraction, and suboptimal results.

In patients with either primary or prior failed, retraction surgery, the authors have used a bilayer dermal regeneration matrix template (Integra) in the posterior lamella for correction of recurrent lower eyelid retraction. Integra (Integra Life Sciences, Plainsboro, NJ) is a bilaminar system with a dermal layer, consisting of a porous matrix of shark glycosaminoglycan and cross-linked bovine tendon collagen, and a silicone epidermal layer.[10] The dermal matrix provides a template for regeneration of host dermis, while the silicone membrane reduces formation of granulation tissue over the matrix, limits moisture loss, and increases structural stability.[10,11] Once native dermis has regenerated, typically at 3–4 weeks, then the silicone layer can be removed.[10,11] The bilayer dermal regenerative template was designed for management of burns and other injuries with extensive skin loss.[10–12] In the periorbital area, it was first reported by Thinda et al.[13] for reconstruction of a large medial canthal wound. Later, Ozgonul et al.[11] reported its use in reconstruction of the orbital socket following exenteration in a series of 5 cases. To the best of our knowledge, this study is the first to report the use of a bilayer dermal regenerative template for repair of lower eyelid retraction.

METHODS

Retrospective review of patients undergoing lower eyelid retraction repair using the described technique (by 4 surgeons) was performed from January 2005 through October 2019.

Collected data included patient demographics, symptoms, preoperative/postoperative lower eyelid position, inferior scleral show,

TABLE 1. Patient demographics

Characteristics	Value (%)
Age, years	
Average	51
Range	11–72
Sex	
Male	9
Female	6
Total cases	
Total no. of patients	15
Total no. of eyelids	19
Bilateral cases	4
Lower eyelid cases	19**
Upper eyelid cases	3*
Follow-up	7 months–14 year
Etiology lower lid retraction	
Thyroid eye disease/negative vector orbit	8 (44.4)
Prior orbital fracture repair	3 (16.7)
Involutional	2 (11.1)
Coloboma	2 (11.1)
Ocular cicatricial pemphigoid	1 (5.6)
Socket contracture	1 (5.6)
Postblepharoplasty	1 (5.6)
Additional procedures	
Tarsal strip	6 (33.3)
Removal of scar tissue	2 (11.1)
Lateral tarsorrhaphy	1 (5.6)
Entropion repair	1 (5.6)
Midface lift	1 (5.6

*Excluded from analysis.
**One lost to follow-up/analysis.

lagophthalmos, etiology of retraction, history of prior retraction surgeries, major/minor complications, and follow-up (minimum 6 months) (Table 1).

There were also 3 cases of upper lid retraction that were also performed using the bilayer dermal regenerative template in the specified time period and were ultimately excluded from the data analysis.

This study was approved by the Institutional Review Board at the University of Wisconsin. The information from this case report was obtained in accordance with the Health Insurance Portability and Accountability Act of 1996 and adhered to the ethical principles outlined in the Declaration of Helsinki as amended in 2013.

SURGICAL TECHNIQUE

A transconjunctival approach 2–3 mm below inferior tarsus was used, with dissection performed to completely release the cicatricial posterior and middle lamella until the lower eyelid was freely mobile. With the eyelid able to be elevated without fibrosis tethering it inferiorly, this allowed the conjunctiva and inferior retractor layers to recess into the fornix, resulting in a posterior lamellar defect. This defect was measured, and the bilayer dermal regeneration matrix template trimmed to an appropriately sized elliptical or crescent-shaped implant, which was then sutured between tarsus and the recessed inferior retractors using interrupted 6-0 absorbable polyglactin or chromic gut sutures (Fig. 1A). The vertical height of the implant ranged 7–12 mm centrally, with the silicone layer facing posteriorly against the globe (Fig. 1B).

In 14 of 19 cases, additional concurrent procedures were also undertaken. Additional concurrent procedures included: 9 Frost tarsorrhaphy, 6 tarsal strip, 2 removal scar tissue, 1 lateral tarsorrhaphy, 1 entropion repair, and 1 midface lift. The Frost tarsorrhaphy was placed for 1 week with no corneal abrasion from the implant edges.

The posterior silicone layer loosened and either spontaneously extruded or was removed in the office at 3–4 weeks after surgery on average (range 3–9 weeks). The silicone layer was soft and pliable and easily pulled from the posterior eyelid with longer follow-up periods. When removed in the first 2–3 weeks, it was noted that the silicone layer often had areas of residual adhesion, requiring several sutures to be cut in the fornix. When the silicone was left for longer, or fewer sutures were placed in the deep fornix edge, the silicone could be pulled easily without any sutures remaining. Once removed, a new white dermal layer could be seen bridging the area behind the spacer, from the inferior fornix to the tarsal edge (Fig. 1C).

RESULTS

Fifteen patients (19 eyelids) were identified from 4 practices (C.B., R.F., M.H., and B.W.) who underwent lower eyelid retraction repair using the bilayer dermal regenerative matrix template implant (Table 2). Three cases using the bilayer dermal regenerative template to correct upper eyelid retraction were excluded, in addition to 1 patient who died shortly after initial follow-up. Ages ranged from 11 to 72 years; 9 M: 6 F. Four patients had bilateral lower eyelid surgery. Indications for surgery included lagophthalmos, exposure keratopathy/irritation, tearing, asymmetry/appearance, and difficulty wearing an ocular prosthesis. Fifty-eight percent of patients had failed prior retraction surgery, that included use of either a porcine acellular dermal graft (ENDURAGen; Tissue Science Laboratories, Aldershot, United Kingdom), bovine dermal matrix (SurgiMend; Integra Life Sciences, Plainsboro, NJ), acellular human cadaveric (AlloDerm LifeCell Corporation, Branchburg, NJ), bioengineered spacer graft (tarSys; IOP Ophthalmics, Costa Mesa, CA) conjunctival rearrangement, recession of inferior retractors, scar tissue removal, and/or horizontal tightening. Those with prior orbital

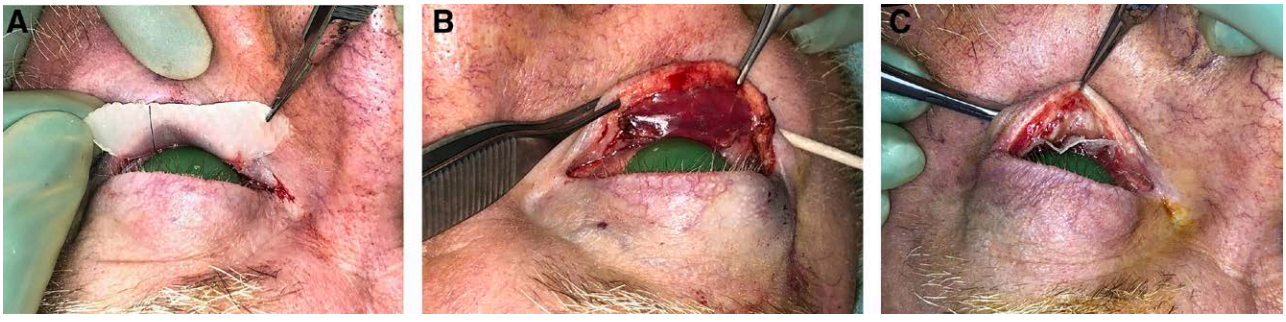

FIG. 1. Surgical technique: (**A**) Placing the appropriately cut template into the posterior lamellar defect. **B**, Bilayer dermal regeneration matrix template in place with silicone side posteriorly toward the globe. **C**, Silicone layer removal at 3–4 weeks with presence of new white dermal layer spanning the area of the graft.

TABLE 2. Summary of cases

Eyelid no.	Sex	Age	Etiology	Concurrent Procedures	Eyelid	Preoperative ISS (mm)	Postoperative ISS (mm) at final visit	Change in ISS (mm)	Days to removal	Prior retraction surgery
1	F	66	TED		RLL	2	0	2	36	Release/recession IR
2	F	66	TED		LLL	2	0	2	36	
3**	M	53	Involutional	LTS, Frost	RLL	3	0	3	Deceased	
4	F	65	TED	Frost	RLL	2	1	1	37	
5	M	11	Coloboma	LTS, Frost	RLL	2	1	1	67	Release IR, hard palate graft
6	M	11	Coloboma	LTS, Frost	LLL	2	1	1	67	
7	M	62	TED	Frost	RLL	3	0	3	53	Release/recession IR, Enduragen
8	M	62	TED	Frost	LLL	3	0	3	53	
9	F	46	TED	Frost	LLL	1.5	0	1.5	25	
10	M	54	TED	Frost	LLL	1.5	2	-0.5	34	
11	F	53	TED	LTS, Frost	LLL	1.0	0.5	0.5	32	Release/recession IR
12	M	72	Socket	Lat Tars	RLL	1.5 but no fornix	0 with good fornix	2	49	Release IR, scar tissue removal, buccal mucous membrane graft x 2
13	M	49	Trauma	LTS, Scar	RLL	2	0	2	22	Release IR, scar tissue removal, buccal mucous membrane graft, hard palate graft
14	F	60	OCP	Entrop Rep	LLL	3	0	3	22	Release IR, scar tissue removal, margin rotation, buccal mucous membrane graft
15	M	55	Trauma	LTS, Scar	LLL	2	0	2	32	Release IR, scar tissue removal, TarSys implant
16	F	58	Blepharoplasty	LTS, MFL	RLL	2	0	2	26	Release/recession IR, Alloderm
17	M	69	Involutional		RLL	2.5	0	2.5	28	Release IR, LTS, Enduragen
18	M	69	Involutional		LLL	3	0.5	2.5	26	Release IR, LTS, buccal mucous membrane, Enduragen
19	M	47	Trauma		LLL	10	3.5	6.5	40	
A	M	72	Socket contracture	Lat Tars	RUL	0* but no fornix	0 with good fornix	0	36	Scar tissue removal, buccal mucous membrane graft
B	F	60	OCP	Entrop Rep	LUL	2*	0.5	1.5	22	Scar tissue removal, buccal mucous membrane graft
C	F	72	Negative Vector		LUL	3*	0	3	20	

ISS, inferior scleral show; Frost, Frost tarsorrhaphy; LTS, lateral tarsal strip; Lat Tars, lateral tarsorrhaphy; Scar, scar tissue removal; MFL, midface lift; IR, inferior retractors.
Eyelid: R, right; L, left; UL, upper lid; LL, lower lid.
*Denotes amount of superior scleral show.
**Died prior to completing follow-up; excluded from analysis.

decompression alone were not considered as retraction surgery failures, although 100% of those with thyroid eye disease in this group did have prior decompression.

Etiology of lower eyelid retraction was thyroid eye disease 44.4% of eyelids. Other etiologies included: prior orbital trauma repair (16.7%), involutional (11.1%), coloboma (11.1%), ocular cicatricial pemphigoid (5.6%), socket contracture (5.6%), and postblepharoplasty retraction (5.6%).

Follow-up ranged from 7 months to 14 years. One patient died shortly after surgery and was excluded from the study. The degree of retraction was measured with inferior scleral show (ISS) for lower eyelid cases. Mean ISS 1.97 ± 0.64mm. Postoperative measurements were taken at a minimum of 1 week, 3–6 weeks, 2–4 months, and 6 months. Mean final eyelid position was measured to be 0.47 ± 0.67 mm. Postoperatively, 90% had good improvement of lower eyelid retraction (defined as 1 mm or less below the inferior limbus) (Fig. 2).

Although the study did not particularly focus on use of the bilayer dermal regeneration matrix template for the upper eyelid, 3 cases were included in Table 2 with the following etiologies: conjunctival scarring/socket contracture, ocular cicatricial pemphigoid, and negative vector orbit (Table 2, Cases A–C). The degree of retraction was measured using superior scleral show for the upper eyelid cases, with results showing that the implant did appear to improve the superior fornix depth to some degree.

Complications were minimal and included transient conjunctival injection, eyelid edema, and foreign body sensation. Conservative management with lubricating tears and ointment were employed. No patients had corneal abrasions, pyogenic granuloma, or required early removal due to pain. There were no cases of implant extrusion. All but 3 patients were satisfied with final results (1 socket contracture due to chemical injury unable to wear prosthesis, 1 coloboma, and 1 thyroid eye disease).

DISCUSSION

Surgical repair of lower eyelid retraction can be challenging, particularly in recurrent cases, where fibrosis and scarring can increase with each subsequent intervention. Use of spacers is helpful in these instances to provide interpositional tissue to bridge the area of released cicatrix, thus minimizing the risk of the edges scarring back together. There are various spacer graft materials available, including autologous materials such as hard palate and auricular cartilage, as well as manufactured products including acellular dermal matrices and porous polyethylene.

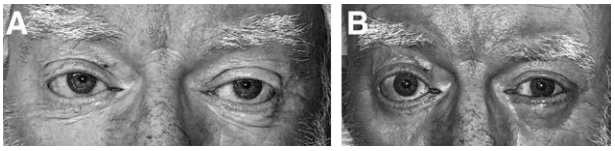

FIG. 2. **A**, Preoperative photo of a patient with bilateral lower eyelid retraction. **B**, Postoperative result after left lower eyelid retraction repair using bilayer dermal regenerative matrix.

Some of these grafts may also provide stiffness and a vertical scaffold for repair.

This study reports a novel use of the bilayer dermal regeneration matrix template, which has been used in other oculoplastic applications, such as exenteration or facial reconstruction[11,13], but has not been described for correction of eyelid retraction. The bilayer template consists of a silicone meshed layer that requires removal, and a second dermal replacement layer.[10] When used as a posterior lamellar spacer graft, the firm silicone layer may provide a rigid scaffolding the critical early postoperative weeks to minimize retraction, similar to the concept of an extended Frost tarsorrhaphy or soft tissue filler to the lower eyelid. For its use in the posterior lamella of the lower eyelid, where there is no host dermis, we presume that the bilayer dermal regenerative template enhances the development of durable dermis-like substantia propria connective tissue that permits conjunctival reepithelialization without underlying contracture; however, postimplantation histopathology was not obtained as part of this study. This theoretically supports the eyelid in an elevated position, by further stretching or lengthening the tissue layers in an upward vector during healing. Leaving the silicone layer in place for at least 3–4 weeks likely helps minimize scar contracture that is typical for this time period in normal healing.

Biointegration of the dermal matrix may also minimize postoperative contraction. However, when the bilayer dermal regenerative template has been used for thermal injuries in the anterior eyelid, there was contracture seen during the early part of the healing process, while waiting for the graft to vascularize.[12]

Further advantages of the material include avoidance of a second surgical site and ample amounts of graft material, allowing the size to be easily customized. The silicone layer appeared to be well tolerated due to its location in the inferior fornix with minimal movement. No patients had corneal abrasions, pyogenic granuloma, or required early graft removal due to pain. Additionally, the temporary nature of the silicone layer avoids the potential complications of the rigid, permanent porous polyethylene spacers, such as outward winging or rotation of the spacer, or implant extrusion.[7]

Our results suggest that the bilayer dermal regeneration matrix template may be considered a reasonable alternative to other spacers to reduce the vertical palpebral fissure. Of the patients included in the study, 90% had good improvement of lower eyelid retraction (defined as 1 mm or less below the inferior limbus) and resolution of preoperative symptoms. The majority of the patients in our study underwent additional procedures at the time of spacer placement, including 9 patients who had a Frost tarsorrhaphy placed for one week after surgery. We did not identify a clear pattern to which patients would benefit from having a Frost tarsorrhaphy as part of their procedure, with surgeon preference dictating which patients received one in this study group. However, no patients experienced an adverse reaction, such as corneal abrasion or pain due to elevation of the implant edge from the tarsorrhaphy; therefore, we believe a tarsorrhaphy could safely be used as an adjunctive procedure to provide additional vertical support for retraction repair. There were no major complications in any patients, such as corneal abrasion, or implant extrusion. In the few patients who did have suboptimal results, these may have occurred due to active cicatrizing conjunctival disease, or residual negative vector of the cheek and orbit.

Even though the bilayer dermal regenerative template was used in some upper eyelid cases, the use of implants are not commonly used in the upper eyelid and were not included in our analysis. The differences in risk and technique warrant further study for use in the upper eyelid.

Although results from the use of the bilayer dermal regenerative template are encouraging, there are some limitations to our study. These include potential variations in surgical technique due to 4 different surgeons, particularly regarding use of concurrent procedures (Frost tarsorrhaphy, tarsal strip, lateral tarsorrhaphy, entropion repair, midface lift). The conclusions that can be drawn about patient selection are also limited by small sample size, lack of a control group, and the retrospective nature of the study.

In conclusion, the bilayer dermal regenerative template may be particularly beneficial in primary, recurrent, or complex cases of eyelid retraction. It also appeared to work well for first-line correction of thyroid retraction. Larger studies and longer follow-up would be useful. We also recognize that these cases are often highly challenging and can potentially benefit from other surgical implant materials as well. It has not yet been studied directly against hard palate and other spacer materials for use in repair of eyelid retraction. Other factors to consider with the bilayer dermal regenerative template include the high cost of the material, and the need for follow-up to remove the silicone layer.

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