




Selection of Site for Harvesting Dermal Grafts as a Spacer in the Correction of Eyelid Retraction

Hung-Chang Chen¹ · Lan-Hsuan Teng¹ · Cheng-I Yen¹ · Shih-Yi Yang¹ · Yen-Chang Hsiao¹ · Jui-Yung Yang¹ · Shu-Yin Chang¹ · Shiow-Shuh Chuang¹ · Po-Jen Huang¹ 



Received: 1 September 2021 / Accepted: 24 October 2021

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Abstract

Background Several materials can serve as spacer grafts in the repair of retracted lower eyelids. However, previous studies did not reveal any of these to be superior to the others. From our perspective, autologous dermal grafts are ideal because they are biologically compatible and abundantly available. However, the absorption of these grafts is an issue, and the thickness of the dermal grafts is crucial. We evaluated the dermal thickness at five potential donor sites using ultrasonography and the efficacy and safety of the posterior neck dermis as a spacer graft in the correction of retracted lower eyelids.

Methods In 20 healthy volunteers, the dermal thickness was assessed using ultrasonography and compared between the posterior neck, upper arm, inguinal area, intergluteal cleft, and gluteal sulcus. Between January 2018 and June 2021, eight retracted lower eyelids in eight patients were repaired using a posterior neck dermal graft. The surgical results of these grafts were also evaluated.

Results The mean age of the volunteers was 37.8 years, and the mean body mass index was 24.45 kg/m². The intergluteal cleft provided the thickest dermis followed by the posterior neck and gluteal sulcus, which were not significantly different. The upper arm and inguinal area had the thinnest dermis without significant differences between them. The mean marginal reflex distance 2/iris ratio decreased by 0.15 ($p=0.008$). The mean cosmetic score

(0–10) for evaluation of lower eyelid reconstruction increased by 3.38 ($p=0.011$). The mean Vancouver Scar Scale score for evaluation of donor site scarring was 3.21. **Conclusions** Although the posterior neck dermis is the second thickest, it is an ideal spacer graft in the reconstruction of retracted lower eyelids. Adequate thickness, uncomplicated methods, and a closer surgical field are its advantages. Additionally, donor site morbidity is minimal, with acceptable scarring.

Level of evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Introduction

Lower eyelid retraction can occur due to several etiologies, including Graves ophthalmopathy, trauma, burns, anophthalmia, skin disorders, or previous lower eyelid surgery, such as blepharoplasty with skin excision. [1–3] Excessive exposure of the infracorneal conjunctiva not only brings about aesthetic concerns but also results in various morbidities, such as dry eyes, exposure keratitis, corneal ulcers, and nocturnal lagophthalmos, which can cause progressive epiphora, photophobia, irritation, and discomfort. [4, 5]

According to previous studies, the management of lower eyelid retraction is based on its severity. Conservative treatments could be effective in patients with mild eyelid retraction; however, moderate-to-severe eyelid retraction may require surgical interventions. [6] Patipa established a series of examinations for patient evaluation, using one to four fingers placed at different sites to push the lower eyelid upward to a satisfactory anatomic position. If one

✉ Po-Jen Huang
andy60875@gmail.com

¹ Department of Plastic and Reconstructive Surgery, College of Medicine, Chang Gung Memorial Hospital, Chang Gung University, Linkou, 5, Fu-Hsin Street, Kwei-Shan, Taoyuan 333, Taiwan, ROC

finger could not reach the ideal result, they then added another finger, and so on. Fingers were sequentially added to pull the lateral canthus, the central lower eyelid margin, and the malar eminence. A spacer graft is indicated in patients who require more than two fingers to reposition the entire lower eyelid. [7]

Autologous dermis is an ideal posterior lamellar spacer. It is biologically compatible and abundantly available. [8] However, from our experiences, its resorption affects its long-term thickness, which is an important factor for reconstructive outcomes. Based on previous studies, the resorption rate of the intergluteal cleft dermis is 28.6–32.2% at 6 months postoperatively and 34.9–39.7% at 12 months postoperatively. [9, 10] Therefore, a thicker dermis is preferred since it remains an adequate volume after resorption. In addition, thicker dermis tissue provides more flexibility for clinical usage because it can be modified based on the patient's needs. The goal of this study was to use ultrasonography to assess and compare the dermal thickness at five sites in healthy volunteers. We also evaluated the efficacy and safety of the posterior neck dermis as a spacer graft in the correction of retracted lower eyelids.

Materials and Methods

It is an Institutional Review Board-approved retrospective study. All the participants completed a written consent form that provided a thorough explanation of the procedures' risks and benefits.

Participants and ultrasound measurements

Between January 2019 and June 2019, the study included 20 healthy Asian volunteers (10 men and 10 women) aged 24–56 years. Those who had skin disorders, history of surgery or trauma at the sites of interest, chronic systemic diseases, or history of long-term use of corticosteroids were excluded. Each volunteer underwent a thorough examination before enrollment in the present study to ensure eligibility. The following characteristics of the participants were recorded: sex, age, height, weight, and body mass index (BMI). Five anatomical regions—posterior neck, medial/posterior upper arm (upper arm), inguinal area, intergluteal cleft, and gluteal sulcus—were assessed using ultrasonography (BenQ T3300, BenQ Medical Technology, Nei-hu, Taipei 114, Taiwan) (Fig. 1).

Ultrasound measurements

All the measurements were performed by the same investigator. BenQ T3300 (BenQ Medical Technology) was

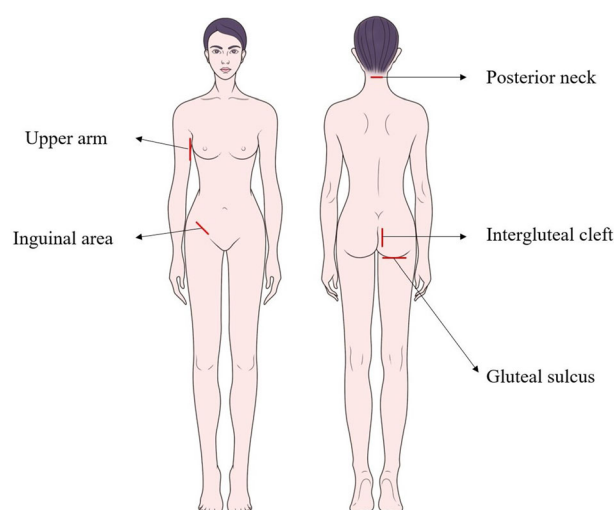


Fig. 1 Evaluation of the dermal thickness using ultrasonography in five anatomical regions: posterior neck, upper arm, inguinal area, intergluteal cleft, and gluteal sulcus.

used for the measurement, and jelly was applied to the skin surface as the medium. The ultrasound probe was held perpendicular to the skin at the donor site with slight contact to avoid compression of the tissue underneath. The vertical thickness of the dermis was measured, recorded, and analyzed.

Lower eyelid retraction repair

Between January 2018 and June 2021, eight retracted lower eyelids in eight patients were repaired using a posterior neck autologous dermal graft. Their demographic data, including the age, sex, etiology, preoperative/postoperative photographs, ocular symptoms, follow-up time, and surgery-related complications, were reviewed.

Marginal reflex distance 2 (MRD2) is the distance between the pupillary light reflex and the lower eyelid margin in the primary gaze. [11] MRD2 of each patient's photograph was standardized by the diameter of the iris. The ratio between MRD2 and the diameter of the iris (MRD2/iris ratio) (Fig. 2) and preoperative/postoperative orbital cosmetic scores were recorded as the outcomes. The



Fig. 2 Ratio between mean marginal reflex distance 2 (MRD2) and diameter of the iris (MRD2/iris ratio).

donor site scar was evaluated using the Vancouver Scar Scale (VSS). The MRD2/iris ratios were assessed using a standard photograph from the National Institutes of Health's Image J system (NIH). The cosmetic score (0–10) for evaluation of the recipient site was assessed by three qualified plastic surgeons before and after the procedure.

Surgical technique

Local anesthesia (2% lidocaine with epinephrine 1:100,000) was administered to the dermis donor site and the lower eyelid. The autologous dermal graft was harvested from the posterior neck. Generally, a 20 × 40-mm elliptical dermal graft was harvested from just below the posterior hairline and trimmed to match the recipient site. The epithelium was removed using a scalpel with a No. 15 blade. The subcutaneous fat was removed, thus leaving a dermis-only graft (Fig. 3). The donor site was closed using 3-0 and 4-0 Vicryl and 5-0 Ethilon sutures layer by layer.

Subsequently, a subciliary incision with careful dissection was performed through lower eyelid retractors. Scars or fibrotic tissues, the septum, and the lower lid retractors were released. The graft was used as a spacer and secured with a 6-0 Vicryl suture beneath the tarsus and at the pre-conjunctival region. An additional lateral tarsal strip was performed in cases of horizontal laxity. [12] The orbicularis oculi muscle and skin were repaired using 6-0 Vicryl sutures and 6-0 plane fast sutures, respectively.

Statistical Analysis

Data are reported as mean ± standard deviation. Analysis of variance was used to compare the dermal thickness between the five areas, and Scheffé's test was then applied for pairwise comparisons between the five groups. The Pearson correlation coefficient was used to evaluate the differences between the dermal thickness and BMI.

Wilcoxon signed-rank tests were used to compare the dermal thickness between the genders and the preoperative and postoperative MRD2/iris ratios and aesthetic scores. Statistical analyses were performed using R v4.1.0 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at $p < 0.05$.

Results

Of the 20 volunteers, 10 were women and 10 were men. The mean age was 37.8 years (range: 24–56). The mean height was 166.4 cm (range: 152–189 cm), the mean weight was 67.8 kg (range: 45–88 kg), and the average BMI was 24.45 kg/m² (range: 18.03–30.43).

The average dermal thickness was 0.28 cm (range: 0.17–0.4) over the posterior neck, 0.11 cm (range: 0.08–0.13 cm) over the upper arm, 0.12 cm (range: 0.07–0.22 cm) in the inguinal area, 0.33 cm (range: 0.26–0.41 cm) in the intergluteal cleft, and 0.25 cm (range: 0.18–0.29 cm) in the gluteal sulcus (Fig. 4) (Table 1).

Significant differences were noted between the dermal thickness in the five groups ($p < 0.001$). Further pairwise comparisons revealed that the intergluteal cleft had a thicker dermis than the posterior neck ($p = 0.008$) and gluteal sulcus ($p < 0.001$). However, the dermal thicknesses of the posterior neck and gluteal sulcus were not significantly different ($p = 0.211$). The dermis was thicker at the posterior neck than that at the inguinal area ($p < 0.001$) and the upper arm ($p < 0.001$). The gluteal sulcus had a thicker dermis than the inguinal area ($p < 0.001$) and the upper arm ($p < 0.001$). However, the difference was not significant between the skin in the inguinal region and upper arms ($p = 0.953$).

Therefore, the intergluteal cleft provided the thickest dermis followed by the posterior neck and gluteal sulcus, which had similar thickness. The inguinal region and the

Fig. 3 A. An elliptical dermal graft measuring 20 × 40 mm is harvested just below the posterior hair line. B. The graft is trimmed to match the recipient site.

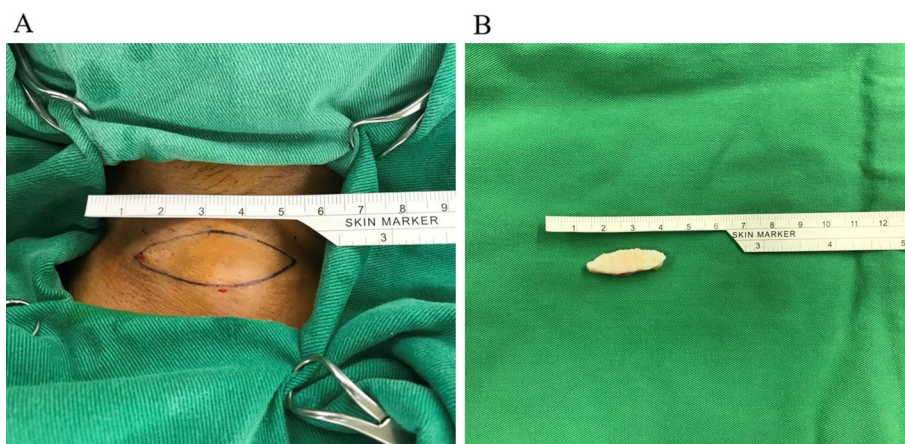


Fig. 4 Ultrasound dermal measurements in the intergluteal cleft, posterior neck, gluteal sulcus, inguinal area, and upper arm (volunteer no. 15).



upper arm had the thinnest dermis without significant differences between them (Fig. 5).

Additionally, correlation analysis revealed that the dermal thickness was positively correlated with BMI over the posterior neck (correlation coefficient=0.667; $p=0.001$), inguinal area (correlation coefficient=0.557; $p=0.011$), and intergluteal cleft (correlation coefficient=0.479; $p=0.033$) in these participants. We also compared the dermal thickness between the sexes and found that male participants had thicker dermis than female participants in the gluteal sulcus ($p=0.016$); however, there were no significant differences in the dermal thickness in other regions.

Eight eyelids of eight patients (three men and five women) with a mean age of 46.13 years were retrospectively included in this study. The average duration of follow-up was 43.5 weeks. The results are summarized in Table 2. The mean

MRD2/iris ratio was 0.67 preoperatively and 0.52 postoperatively; the difference of 0.15 was significant ($p=0.008$). The mean cosmetic score of the recipient site was 3.79 preoperatively and 7.17 postoperatively; the score significantly increased by 3.38 ($p=0.011$). The cosmetic appearance improved significantly postoperatively with high satisfaction levels reported by the patients (Fig. 6). The mean VSS score was 3.21 in the eight patients (Table 2). There were no recipient site infections, development of hair follicles, or epidermoid inclusion cysts around the surgical field in these patients. No donor morbidity was observed, and the scar appearance was acceptable (Fig. 7).

Furthermore, most patients reported improvements in their symptoms, such as dry eye with reflex tears, foreign body sensation, and impaired vision along with reduced use of topical lubricants.

Table 1 Demographic data of 20 volunteers and ultrasound dermal thickness measurements of five anatomical regions

No.	Gender	Age	Body height	Body weight	BMI	Posterior neck (cm)	Upper arm (cm)	Inguinal area (cm)	Intergluteal cleft (cm)	Gluteal sulcus (cm)
1	M	41	172	86	29.07	0.34	0.09	0.08	0.33	0.24
2	M	31	189	88	24.64	0.28	0.11	0.14	0.33	0.29
3	M	39	163	79	29.73	0.28	0.11	0.22	0.34	0.27
4	M	28	170	65	22.49	0.23	0.09	0.08	0.30	0.28
5	M	26	175	72	23.51	0.27	0.09	0.09	0.30	0.27
6	M	30	173	70	23.39	0.33	0.11	0.11	0.32	0.29
7	M	26	174	68	22.46	0.25	0.12	0.15	0.31	0.29
8	M	31	173	68	22.72	0.17	0.11	0.09	0.26	0.25
9	M	30	180	80	24.69	0.31	0.10	0.17	0.33	0.27
10	M	52	160	68	26.56	0.30	0.10	0.12	0.41	0.24
11	F	56	163	68	25.59	0.40	0.13	0.13	0.39	0.24
12	F	51	155	56	23.31	0.28	0.08	0.09	0.27	0.21
13	F	42	152	52	22.51	0.30	0.10	0.09	0.36	0.26
14	F	30	167	60	21.51	0.17	0.10	0.10	0.28	0.27
15	F	42	155	60	24.97	0.31	0.10	0.11	0.34	0.20
16	F	41	169	57	19.96	0.26	0.11	0.09	0.34	0.18
17	F	38	160	75	29.30	0.33	0.12	0.17	0.31	0.25
18	F	50	157	75	30.43	0.37	0.13	0.13	0.39	0.26
19	F	48	163	64	24.09	0.25	0.13	0.07	0.34	0.27
20	F	24	158	45	18.03	0.19	0.08	0.08	0.29	0.20
Mean		37.80	166.40	67.80	24.45	0.28	0.11	0.12	0.33	0.25
SD		9.9	9.5	11.0	3.3	0.06	0.02	0.04	0.04	0.03

Bold values represent the category of each column

BMI Body mass index

SD Standard deviation

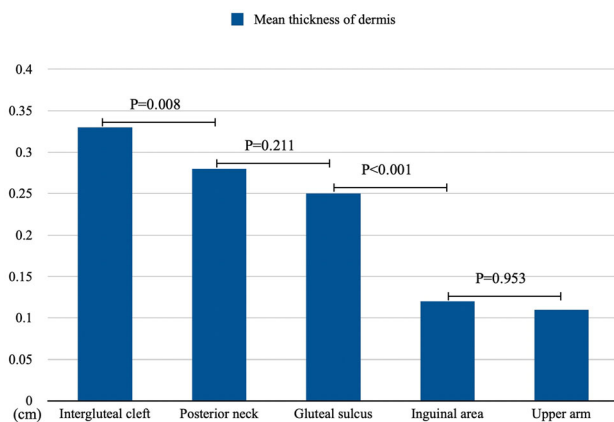


Fig. 5 Mean dermal thickness in the five body regions. Intergluteal cleft > posterior neck = gluteal sulcus > inguinal area = upper arm.

Discussion

The thickness of the skin varies between different areas of the body, and skin biopsy is commonly used to measure skin thickness. [13, 14] However, the shrinkage—

especially the vertical shrinkage—of the biopsied skin cannot be entirely prevented. [15] Ultrasound evaluation of the skin is a non-invasive and effective approach, and several prior studies have used it to assess skin thickness. [16–20] Nevertheless, none have specifically focused on the potential body sites for dermal grafts.

The upper arm, inguinal area, intergluteal cleft, and gluteal sulcus are common graft donor sites. Dermal grafts are easy to harvest in these areas, and the donor site scar is concealable. [21–23] Additionally, the donor site morbidity is negligible. In this study, we measured the dermal thickness in the five anatomical regions using ultrasonography. The order of decreasing dermis thickness was as follows: intergluteal cleft > posterior neck = gluteal sulcus > upper arm = inguinal area. Although dermal thickness is not the only factor to consider when deciding on a dermal graft, this information is useful in performing specialized reconstructions for various defects in the body.

During the repair of retracted lower eyelids, all scarred and fibrosed tissues and lower lid retractors need to be released; therefore, a strong and steady spacer is necessary

Table 2 Demographic data of 8 patients underwent lower eyelid retraction repair using dorsal neck autologous dermal graft

Patient no.	Eye	Gender	Age	Etiology	Preop MRD2/Iris ratio	Postop MRD2/Iris ratio	Change of MRD2/Iris ratio	Preop cosmetic score*	Postop cosmetic score*	Change of cosmetic score*	VSS	Follow up (week)	Graft size (mm)
1	Right	F	64	Cicastrical ectropion	0.96	0.54	- 0.42	2.67	9.00	6.33	3.00	13	15 × 30
2	Left	F	14	Cicastrical ectropion	0.6	0.53	- 0.07	4.00	3.67	-0.33	6.00	5	15 × 35
3	Right	M	25	Congenital	0.53	0.44	- 0.09	6.00	9.00	3.00	5.33	73	20 × 40
4	Left	M	62	Facial palsy	0.58	0.54	- 0.04	3.00	7.33	4.33	1.00	52	20 × 35
5	Right	F	55	Thyoid eye disease	0.48	0.44	- 0.04	4.00	8.00	4.00	1.67	114	15 × 45
6	Left	M	47	Cicastrical ectropion	0.73	0.63	- 0.10	4.00	4.67	0.67	2.67	11	15 × 40
7	Left	M	40	Cicastrical ectropion	0.69	0.49	- 0.20	4.33	7.67	3.34	3.00	57	20 × 40
8	Left	M	62	Cicastrical	0.82	0.56	- 0.26	2.33	8	5.67	3.00	23	20 × 40
Mean			46.13		0.67	0.52	- 0.15	3.79	7.17	3.38	3.21	43.50	
SD			18.6		0.16	0.06	0.13	1.15	1.96	2.28	1.69	37.8	
							(<i>p</i> =0.008)			(<i>p</i> =0.011)			

*Cosmetic scoring (0–10), the column showed the average score of 3 different plastic surgeons

Preop: preoperative

Postop Postoperative

VSS Vancouver scar scale

MRD2 Marginal reflex distance 2

SD standard deviation

Fig. 6 a. Patient no. 7 with left lower eyelid retraction due to trauma. Preoperative (left) and postoperative (57 weeks) (right) photographs. **b.** Patient no. 5 has left lower eyelid retraction due to thyroid eye disease. Preoperative (left) and postoperative (114 weeks) (right) photographs.



for eyelid support. Currently, various materials can be used as spacer grafts in lower eyelid reconstruction, such as hard

palate mucosa, auricular cartilage, dermis, dermal fat graft, tarsal conjunctiva, porous polyethylene, and acellular

Fig. 7 **a.** Patient no. 4. Posterior neck donor site at 52 weeks postoperatively shows an inconspicuous scar. **b.** Patient no. 5. Posterior neck donor site scar at 114 weeks after the surgery. **c.** Patient no. 7. Posterior neck donor site scar at 57 weeks after the surgery. The scar can be hidden by hair.



tissue matrix. However, previous reviews did not identify the superiority of any of these materials over the others. [24–26] Hard palate mucosa was considered the gold standard because of its stiffness and mucosal surface. Nevertheless, high-level surgical skill demand, increased operative time, donor site morbidity, postoperative pain, and hemorrhage are concerning. [24, 26–28] The long period of keratinization after the procedure has also been previously reported. [29] However, although ear cartilage graft is the stiffest spacer and has benefits in effective reconstruction, noticeable contour deformities and palpation of the graft for years after the operation limit its clinical use. [24, 27, 28] The effectiveness of synthetic materials varies among different products and shows variable tissue tolerance in patients. Furthermore, the risk of infection is a potential complication. [25] Therefore, we are convinced that an autologous dermal graft is a relatively ideal material because it has a great pliability, it is available in abundance, and it is obtained from the same patient, which prevents the risk of disease transmission or rejection. Additionally, dermal grafts are easy to harvest, and donor site morbidity is negligible. [8, 30] We summarize all possible graft materials with advantages and disadvantages in Table 3.

Based on ultrasound measurements, the posterior neck dermis was the second thickest donor dermis. The mean intergluteal cleft dermal thickness is only 0.4 mm thicker than the dorsal neck (3.2 vs. 2.8 mm, respectively). Although a thicker dermis is steadier and preferable, it is

not the only factor to be considered while selecting an autologous dermal graft. We prefer the dorsal neck as the donor site and not the intergluteal cleft or gluteal sulcus for several reasons. The dorsal neck is close to the surgical field and is easy to prepare. There is plenty of tissue in this area for grafts of various sizes, and harvesting is simple. When placing the patient in the lateral decubitus position, suturing the recipient site and closing the donor site can be performed simultaneously, thus reducing the operative time. The subsequent scarring is acceptable and can be hidden by hair. In contrast, the intergluteal cleft is distant from the eye and, therefore, we need to prepare two surgical fields. Furthermore, the intergluteal cleft is close to the anus, a relatively unclean area, which can increase the risk of postoperative wound complications, such as wound dehiscence and sinus formation. [23] In this study, there were no donor site complications over the posterior neck. The donor dermis is the thinnest in the upper arm and inguinal area; the dermis in these areas is less than half as thick as that of the posterior neck. We had attempted utilizing the inguinal dermis for retracted lower eyelid repair and found that the graft was largely resorbed, thus resulting in under-correction of the lower eyelid. Consequently, we no longer used the upper arm or inguinal dermis in correcting retracted lower eyelids.

In this study, we inserted the dermal graft beneath the tarsus in the preconjunctival area rather than deep in the fornix as was performed by Korn et al. [22]; in their study, the dermal graft was anchored deep in the fornix and

Table 3 Advantages and disadvantages of different spacer grafts for lower eyelid retraction reconstruction.

	Autologous materials				Allo-dermal or Xenodermal graft	Synthetic spacer graft
	Autologous dermal graft	Hard palate mucosa graft	Auricular cartilage graft	Tarso-conjunctival graft		
Advantages	1. Abundant tissue 2. Low donor site morbidity 3. Good aesthetic outcomes	1. Stiffness 2. Mucosal surface 3. Low resorption rates 4. Good aesthetic outcomes	1. Stiffness 2. Low donor site morbidity 3. Low resorption rates	1. Stiffness 2. Mucosal surface 3. Low donor site morbidity 4. Good aesthetic outcomes	1. Stiffness 2. Easy to use 3. Short operation time 4. No donor site morbidity 5. Good aesthetic outcomes	1. Stiffness 2. Easy to use 3. Short operation time 4. No donor site morbidity
Disadvantages	1. Less stiffness 2. High resorption rates	1. High surgical skill 2. Long operation time 3. Donor site morbidity 4. Pain 5. Hemorrhage 6. Long period of keratinization	1. Contour deformities 2. Long period of palpation of graft	1. High resorption rates 2. Little tissue amount	1. Variable outcomes 2. Risks of disease transmission 3. Expensive	1. Variable outcomes 2. Risks of infection 3. Expensive

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secured to the cut edges of the conjunctiva. Our method avoids keratinization of the conjunctiva and the associated corneal discomfort. We did not encounter any recipient site complications, such as the growth of hair follicles, development of epidermoid inclusion cyst, or infection.

The current study has some limitations. There could be other prospective donor sites that were not included in this study; comparing the resorption rates and thickness of the dermis from different donor sites may require further studies. Since we aimed to determine the dermal thickness among different areas of the body in healthy people to provide evidence for further clinical decisions, only healthy subjects were recruited in our study; therefore, our study findings may not reflect the variation among patients with underlying diseases. No previous biological evidence supported that a thicker dermal graft would still remain thicker after tissue absorption, which also required further investigation. This was a retrospective study and did not include comparisons or control groups; therefore, we cannot conclude that posterior neck dermal grafts are superior to other

grafts. In addition, only autologous posterior neck dermal grafts were investigated in our study, which lacked comparisons with other spacer graft materials. The number of patients was limited (eight eyelids in eight patients) and the etiology varied between them. The follow-up period was restricted in some patients, and some complications may take longer to manifest.

Conclusions

Ultrasonography was used to evaluate dermal thickness at five potential donor sites. Although the dermis from the posterior neck was the second thickest dermal tissue, it was an ideal spacer graft in the reconstruction for the retracted lower eyelid. Adequate thickness, uncomplicated methods, and proximity to the surgical field were its advantages. Additionally, donor site morbidity was minimal with an acceptable scar, which could be easily hidden by hair.

Declarations

Conflict of interest The authors have no conflict of interest to disclose.

Ethical Approval It is an Institutional Review Board-approved retrospective study.

Consent to Participant All the participants completed a written consent form that provided a thorough explanation of the procedures' risks and benefits.

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