Aesth Plast Surg
https://doi.org/10.1007/s00266-022-03114-z

ISAPS

ORIGINAL ARTICLE OCULOPLASTIC

Fat Injection as a Valuable Tool for Lower Eyelid Retraction Management: A Retrospective, Observational, Single Blind and Case—Control Study

Michele Pascali[1,3] · Gloria Marchese[1] · Alberto Diaspro[2]

Received: 16 April 2022 / Accepted: 17 September 2022

Abstract

Background The aim of this study was to evaluate the use of autologous fat graft injection to correct lower eyelid position

Methods A retrospective, observational, single blind, case—control study was carried out on 94 patients, presenting with lower eyelid retraction in 159 eyes. In the sub-population with monolateral eyelid retraction, the not affected site has been considered as a control and compared with the outcomes recorded after treatment of the contralateral side

Follow-up at 12 months was performed with a subjective assessment carried out by a questionnaire administered to patients while objective result assessment was performed 12 months after surgery by two independent blind examiners.

Results The eyelid upward reposition has improved one year after fat grafting in both bilateral (1,52 mm) and unilateral (1,7 mm) population: the latter allowed to statistically validate ($P<0.05$) the result with respect to the not affected site.

Conclusions This is the first paper that highlights the outcomes of sole fat injection in the treatment of lower eyelid retraction: blind objective evaluation of surgical outcomes along with a patient assessment of both functional and aesthetic improvement one year after surgery confirm its efficacy and reliability along with the first case/control outcome evaluation of the technique carried on in the sub-population of 29 patients affected by unilateral lower eyelid retraction that validate the average improvement of the retracted eyelid one year after fat grafting as statistically significant. Nevertheless, longer follow-up periods and a larger sample size are needed to thoroughly confirm surgical outcomes and statistical results.

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.

Keywords Eyelid · Retraction · Fat · Treatment

Introduction

Cosmetic blepharoplasty is one of the most requested surgical procedures [1], and although expert practitioners continuously develop the finest techniques, the rising rate of unsatisfactory results and post-surgical complications have led to a larger demand for secondary surgery.

Lower eyelid retraction (LER) represents one of the most frequent complications following lower eyelid blepharoplasty [2].

Spacer grafts are usually adopted to correct LER [3], [4]; however, other approaches have also been described: full-thickness skin grafts [5], locoregional flaps [6], [7], lateral suspension system surgery [8], [9], [10] or midface lifting procedure [11], [12], [13].

Despite the reported success of the techniques mentioned above, their invasiveness is poorly accepted by patients and appears to be associated with a risk of complications when they are not properly carried out.

✉ Alberto Diaspro
info@albertodiaspro.com

[1] Rome, Italy

[2] Rigeneralab Centre for Regenerative Medicine, Corso Unione Sovietica 159/a, 10134 Turin, Italy

[3] Plastic Surgery Academy, Via Novara 53, 00198 Rome, Italy

Published online: 17 October 2022

Moreover, surgical outcomes may be unsatisfying, and patients may rarely be willing to accept adjunctive major surgery to correct previous results or complications. The possibility of offering a simple and reliable solution could therefore be of major interest to them.

With this regard, the authors here conducted a retrospective observational study to evaluate fat graft efficacy for the correction of lower eyelid position in patients affected by LER.

Methods

Patient Selection

A retrospective study was carried out on 94 patients operated between January 2015 and January 2018, presenting with remaining LER in 159 sites.

Institutional Review Board/Ethics Committee ruled that approval was not required for this study.

The study protocol followed the ethical guidelines of the Declaration of Helsinki, and an informed consent form (ICF) for the treatment was acquired from all patients before the surgical procedure, along with permission for photographic reproduction.

Thirty-two patients were males with a mean age of 61.2 years (range 45 to 73 years), and sixty-two were females, with a mean age of 53.5 years, (range 41 to 64 years).

LER was secondary to cosmetic lower blepharoplasty in 55.32% of cases (52 out of 94 patients); it was involutive in 21.28% of cases (20 out of 94 patients); in 15.96% of cases (15 out of 94 patients), it was secondary to oncological eyelid surgery, and in 7.44% of cases (7 out of 94 patients), it occurred because of previous facial trauma.

Study population is shown in Table 1.

Preoperative Evaluation and Eligibility Criteria

A complete ophthalmologic examination was performed 6 months after previous corrective surgery, and residual retraction in the assessed patient population was included between 0 and II on Ectropion Grading Scale (EGS) introduced by Moe and Linder [14].

LER assessment in the study population is shown in Table 2.

Symmetry and position of the lower eyelid were assessed; 'snap-back test', 'pinch test' and the 'distraction test' were run to highlight lid laxity in three directions (vertical, horizontal and sagittal). 'Snap test' was performed to evaluate the palpebral tone along with 'vertical traction test', by pushing the lower eyelid upward to the cornea to check its capability to cover the upper limbus without resistance.

Whenever fixed or if minimal movement only was allowed, lid retraction was judged secondary to anterior lamella defect, and the patient was excluded from the presented study.

If medial movement due to lateral canthal tendon laxity was more than 2 mm, then looseness of canthal ligament/tendon complex was registered and patient was excluded (as canthopexy was indicated instead).

Subjective evaluation was carried out on analysis of patients' answer to a Global Aesthetic Improvement Scale (GAIS) and based on a questionnaire on ocular symptoms assessment sent before and 1 year after the surgical procedure.

Photometric Evaluation

Documentation with full-size 1:1, photographs of each patient looking straight forward in the standing position were taken (Frankfurt horizontal plane).

Position, facial expression, focal distance and camera settings were determined, and photographs were sized with Adobe Photoshop CC (Adobe Systems Inc, San Jose, CA) to ensure that initial proportions were maintained.

Objective linear measurements were obtained with Adobe Illustrator CC after a blue interpupillary line was drawn. The degree of eyelid retraction was estimated, by tracing a red line tangentially to the lateral part of the limbus and perpendicular to the blue one, and by recording the distance in millimeters between this line and the lower eyelid margin as shown in Fig. 1.

Table 1 Study population

LER	*N* Patients	*N* Grafted Eyelids	LER unilateral	*N* Grafted Eyelids
Iatrogenic: Rejuvenation	52	90	7	97
Involutive	20	40	0	40
Iatrogenic: Post-oncological	15	0	15	15
Trauma	7	0	7	7
n (eyelid)		130	29	159
n (patients)	94	65	29	

LER lower eyelid retraction

Table 2 LER assessment on EGS in study population

LER	*n* Patients	LER moderate	LER severe	n Grafted Eyelids
Iatrogenic: Rejuvenation	52	81	16	97
Involutive	20	40	0	40
Iatrogenic: Post-oncological	15	3	12	15
Trauma	7	3	4	7
n (eyelid)		127	32	159

LER Lower eyelid retraction, *EGS* Ectropion grading scale

Patients' photographs were randomized, and measurements were performed prior to and 12 months after surgery by two independent blind examiners.

Surgical Procedures

Fat Harvesting

Surgery was performed by the same senior surgeon at all times.

Donor area was infiltrated using a 3 mm Klein blunt tip cannula with a solution containing 0.9% NaCl, 0.25% mepivacaine with 1:500.000 epinephrine. Hand syringe liposuction was performed with 2 mm diameter, 14 cm length blunt tip microcannula with 4 spiral 2.5x1 mm holes (Bmed S.r.l., Via Mincio, 166 – 47842 San Giovanni in Marignano RN, Italy), attached to a 10 cc Luer-lock syringe (Becton Dickinson Italia S.p.a., Via Cialdini, 16 – 20161 Milano) under light negative pressure to provide for a more delicate aspiration.

The mean amount of harvested fat was 20.7 mml (range 10-35 ml).

Fat Processing

The harvested fat was washed with saline solution respecting a fat-to-saline solution equal to 1:4.

Syringes were then placed vertically for decantation and separation into a bloody part full of infiltration and washing liquid, and the fatty component to be used.

The derived fat was then filtered by using a 0.4 mm filter. When planned to be injected in the anterior lamella, it was filtered by using a 0.2 mm filter (Bmed S.r.l., Via Mincio, 166 – 47842 San Giovanni in Marignano RN, Italy) as shown in Fig. 2. Fat was then transferred from the 10-ml syringe to the 1-ml Luer-lock syringe through a two-way connector (Becton Dickinson Italia S.p.a., Via Cialdini, 16 – 20161 Milano).

Fat Injection

The recipient site was prepared for fat transfer by making a network of multiple criss-crossing tunnels using an empty cannula through a hole 1 cm lateral and caudal to the lateral canthus.

Fat was then injected with a slight pressure, deep to the orbicularis muscle using a 1 mm diameter, 9 cm length blunt tip microcannula with 2.5x0.8 mm holes (Bmed S.r.l., Via Mincio, 166 – 47842 San Giovanni in Marignano RN, Italy).

Micro-tunnels carried out at different depth allow to properly spread the injected fat with a fan technique on the anterior and intermediate lamella, and through the scarry tissue down to the posterior one, and this leads to confirm from a clinical point of view that the cicatricial reaction is tri-dimensional and thus involving the entire eyelid.

Further injection was then made inferiorly at the eyelid-cheek junction and in the malar fat pad to grant the correct volume and superiorly toward the tarsus for lower eyelid support and repositioning.

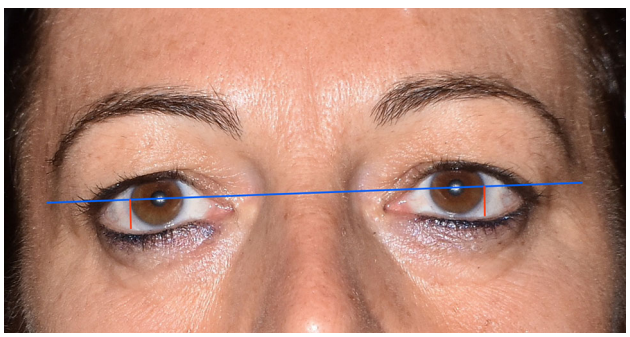

Fig. 1 Objective measurements on photographs

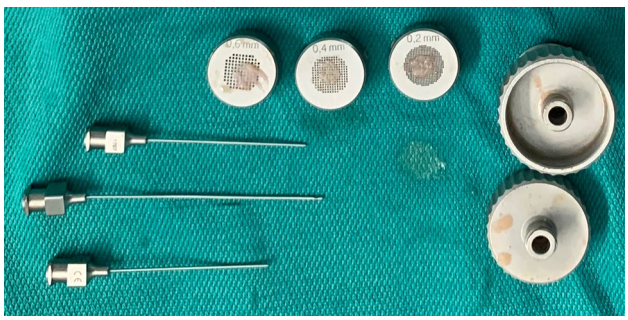

Fig. 2 Cannulas and filters for fat processing and grafting

Afterward, the posterior lamella would be injected, and care was taken not to pierce the conjunctiva, moving the cannula parallel to a plane outline from the external to the internal canthus.

Cannula tip position was kept under control by checking on the conjunctival fornix. The retrograde injection of fat was carried out, toward the arcus marginalis and then the tarsus, fanning out at a 30° direction and avoiding to push the cannula along a caudo-cranial vector, thus piercing the conjunctiva with the tip.

The amount of fat placed into each side ranged from 2.2 to 3.5 ml (mean 2.8 ml) in the tear through and lower eyelid while 3.2 to 6.7 ml (mean 4.95 ml) was injected in the malar region.

Once the fat was injected, it was then possible to observe the rise of the eyelid margin and the sealing of the tarsus, thus confirming that fat injection allowed not only to restore the volume but also to produce a 'spacer' effect as shown (see Video, Supplemental Digital Content 1).

Postoperative Care

Steri-Strips (3M Italia S.r.l., Via Bobbio, 21 – 20096 Pioltello MI) were applied to seal the cannula entrance sites at the lateral canthal region and to gently compress the eyelid to avoid swelling.

Paper tapes with light compression were used in the areas of lipo-aspiration. Systemic antibiotic therapy for 7 days was administered to every patient.

Statistical Evaluation

The primary outcome was the lower eyelid retraction repositioning, obtained comparing the preoperative image (T0) with one-year postoperative image (T1) in the study population (n=159), as shown (see Supplemental Digital Content 2).

The same comparison has been made in the affected site of the monolateral eyelid retraction group (n=29), as shown (see Supplemental Digital Content 3).

Statistical evaluation was calculated with respect to the preoperative lower eyelid position (see Supplemental Digital Content 4); the significance threshold was set at $p<0.05$.

A case—control evaluation was made in the monolateral eyelid retraction group, comparing the one-year outcome of the treated side (case) with the healthy eyelid (control), along with its statistical evaluation with significance threshold set at $p<0.05$, as shown (see Supplemental Digital Content 5).

Statistical analysis was performed by using GraphPad Prism version 6.0.0 for Windows, GraphPad Software, San Diego, California USA, www.graphpad.com

D'Agostino-Pearson normality test was adopted to test the distribution of analyzed groups. Two-tailed paired t test, or Wilcoxon matched-pairs signed rank test in case of nonparametric distribution, were the chosen methods to compare data in both studies.

Results

All the examined patients underwent fat graft injection in the lower eyelid and malar region to correct remaining LER, as shown in Figs. 3, 4 and 5

The procedure takes less than 20 minutes, and no intraoperative complications was encountered.

All patients experienced minimal postoperative pain. Mild edema disappeared within 4 days.

The analysis of the subjective evaluation after 1-year follow-up is shown in Table 3: patients' satisfaction related to aesthetic improvement shifted from 2.9 (mean value, standard deviation, sd +/- 1.3) to 8.7 (mean value, sd +/- 1.2) on a 0-10 GAIS. All symptoms related to functional impairment showed a great relief (>90%) as indicated, and blurred vision was no longer present.

Table 4 shows the recorded distances before and 1 year after surgery: fat grafting has allowed an average lower eyelid upward repositioning of 1.52 mm in the population of patients affected by bilateral LER; the improvement was statistically significant with a $p<0.05$ (see Supplemental Digital Content 6).

In the sub-population of 29 patients affected by unilateral LER (see Table 5), the average lower eyelid upward repositioning was 1.71 mm.

The outcomes recorded in this sub-population allowed the authors to perform a case/control study to validate the results of the adopted technique with a $p<0.05$, as shown (see Supplemental Digital Content 7).

Three patients (3.2%) presented with specific complications: a local infection treated with antibiotics that resulted in a milder eyelid retraction that required a tarsal strip procedure to be corrected and has therefore been

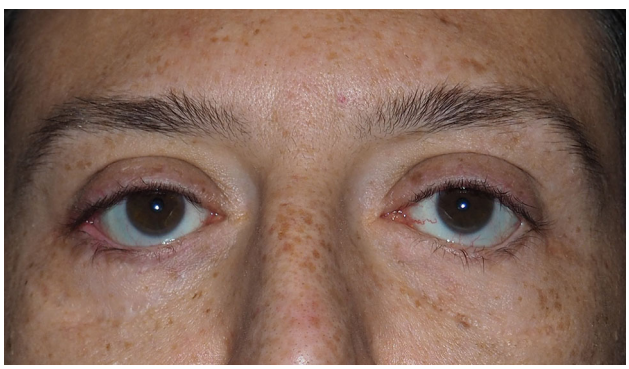

Fig. 3 Patient 1, iatrogenic LER (previous blepharoplasty for eyelid rejuvenation). Before surgery

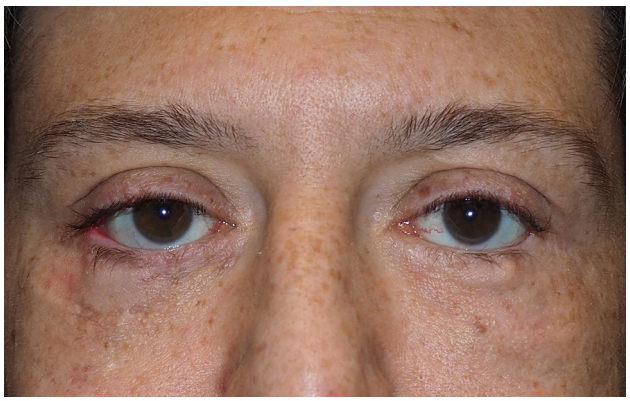

Fig. 4 Patient 1, iatrogenic LER (previous blepharoplasty for eyelid rejuvenation). 6 months after midface lift, tarsal strip and autogenous spacer grafting.

Fig. 5 Patient 1, iatrogenic LER (previous blepharoplasty for eyelid rejuvenation). 52 weeks after fat grafting to correct remaining LER

excluded from the present study, while in two patients a local edema persisted for more than 3 months; in the latter conservative management led to a total resolution of the problem.

Discussion

Lower eyelid retraction (LER) is a severe functional and aesthetic problem.

The position of the lower eyelid is normally determined by its intrinsic laxity, the distensibility of lower eyelid retractor, the adequacy of the fornix and palpebral conjunctiva, the location of canthal ligament and the orbicularis oculi muscle tonicity [15]: any alteration related to the abovementioned structures increases the likelihood of LER.

LER patients often present with prominent eyes and flat cheeks, negative canthal tilt and midface descent that leads to lower eyelid inability to maintain itself at the inferior limbus [2] enhanced by tissue scar reaction and septum adhesion. [11]

The abovementioned conditions all serve as criteria for the need of additional procedures aimed at preventing LER.

Involutive eyelid retraction is related to the inadequate balance between upward resistance of tarsus, canthal ligament and tendon—along with orbicularis oculi muscle

Table 3 Subjective evaluation in study population (*n*=94), 52 weeks after surgery

Symptoms	Before surgery	After surgery
Ocular discomfort	94 (100%)	3 (3,1%)
Redness	90 (95.7%)	2 (2,12%)
Burning	94 (100%)	3 (3,1 %)
Excessive tearing	94 (100%)	1 (1,06%)
Photophobia	89 (94.6%)	5 (5,3%)
Blurred vision	68 (72.3%)	0 (0%)
Aesthetic satisfaction (GAIS) mean +/- SD	2.9 +/- 1.3	8.7 +/- 1.2

GAIS Global aesthetic improvement Scale (from 0 – unsatisfied to 10 - fully satisfied)

Table 4 Recorded outcomes in study population (*n*=94), 52 weeks after surgery

Time of photograph	*n*	Distance between the inter pupillary line and the lower eyelid margin		
		Minimum	Maximum	Mean
Preoperative	159	4,30mm	13,4 mm	8,77 mm
1-year Postoperative	159	3,97 mm	12,5 mm	7,25 mm

Table 5 Recorded outcomes in monolateral lower eyelid retraction population (n=29), 52 weeks after surgery

Time		Grafted eyelid n	Distance between the inter pupillary line and the lower eyelid margin (mm)		
			Minimum	Maximum	Average
Preoperative (t0)					
	Blepharoplasty	7	5,6	10,6	
	Tumor	15	6,2	13,1	
	Trauma	7	6,4	11,5	
	Total	29			8,58
1-year postoperative (t1)					
	Blepharoplasty	7	4,5	9,7	
	Tumor	15	4,5	11,5	
	Trauma	7	5,2	10,1	
	Total	29			6,87

tension—and the downward pull of midface gravitational descent and the associated lack of support.

In iatrogenic eyelid retraction, the downward action of scar shrinking results in either excessive shortening of the anterior lamella, further displacement of the posterior lamella, or full-thickness adherence between the orbital septum and its surrounding tissues [11], [16].

The use of fat grafting has been advocated for these instances [17], [18], [19], [20] as its depletion after surgery is correlated to a worsening of the retraction [21].

LER occurrence or relapse is the unpredictable result of mistaken surgical approach [8], [9], [11] that may benefit from retractor release surgery [3], [22], [23], lateral suspension [8], [9] [24], [25] or malar fat pad elevation [12], [26], [27], since the main problem to deal with is in fact always the unpredictable scarring reaction (see Figs. 6, 7, 8, 9, 10 and 11).

For residual LER correction, it is preferable to avoid further surgical dissection and to work with closed procedures to minimize damage to structures of the eyelid [18]:

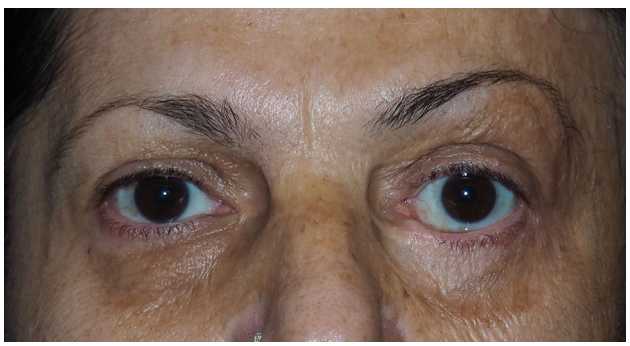

Fig. 6 Patient 2, post-traumatic LER (previous facial burn). Frontal view, before surgery

furthermore, if there is any scarry tissue, then its softening is the goal to be achieved with fat grafting (see Figs. 12, 13, 14, 15, 16 and 17).

Fat further provides injectable volumetric support [28], [29], [30] [31], [32] that shows its efficacy in providing

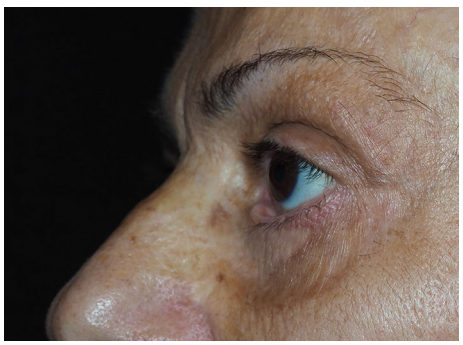

Fig. 7 Patient 2, post-traumatic LER (previous facial burn). Lateral view, before surgery

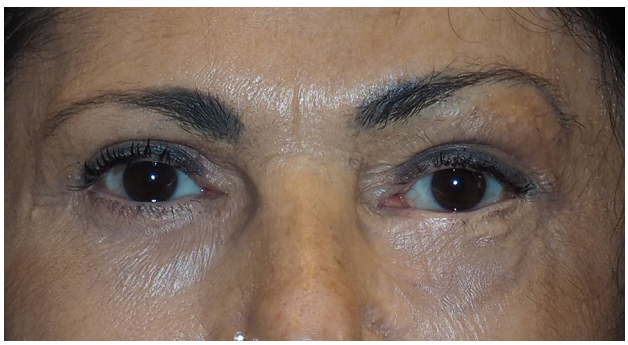

Fig. 8 Patient 2, post-traumatic LER (previous facial burn). Frontal view, 52 weeks after midface lift, tarsal strip and autogenous spacer graft to correct ineffective previous skin graft to left lower eyelid and fat grafting to correct remaining LER

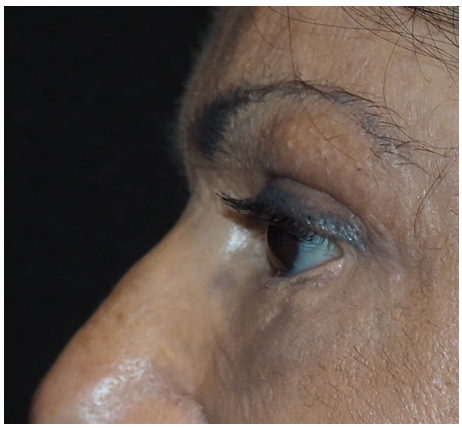

Fig. 9 Patient 2, post-traumatic LER (previous facial burn). Lateral view, 52 weeks after midface lift, tarsal strip and autogenous spacer graft to correct ineffective previous skin graft to left lower eyelid and fat grafting to correct remaining LER

Fig. 10 Patient 3, iatrogenic LER (previous blepharoplasty for eyelid rejuvenation). Before surgery

Fig. 11 Patient 3, iatrogenic LER (previous blepharoplasty for eyelid rejuvenation). 52 weeks after tarsal strip, canthal scar revision and fat grafting to correct LER

eyelid expansion and reinforcement, albeit temporarily [33], [34], [35], [36].

Fat injection not only flattens out palpebro-malar depression, but also raises the lid rim and reduces the amount of scleral show [33]

This is not just a matter of adding volume: the grafted adipocytes that survive because of the proximity to the recipient tissue are indeed only of relative importance [37].

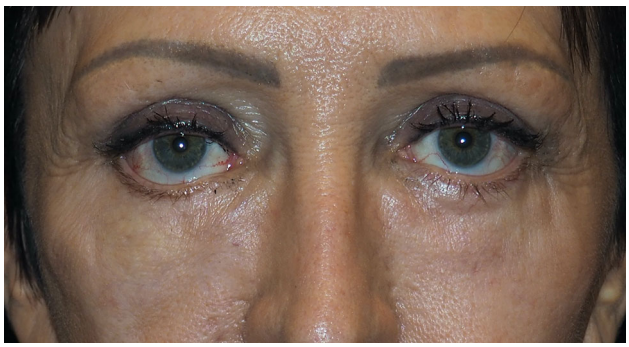

Fig. 12 Patient 4, iatrogenic LER (secondary to removal of previously injected silicone in the malar area). Frontal view, before surgery

Fig. 13 Patient 4, iatrogenic LER (secondary to removal of previously injected silicone in the malar area). Oblique view, before surgery

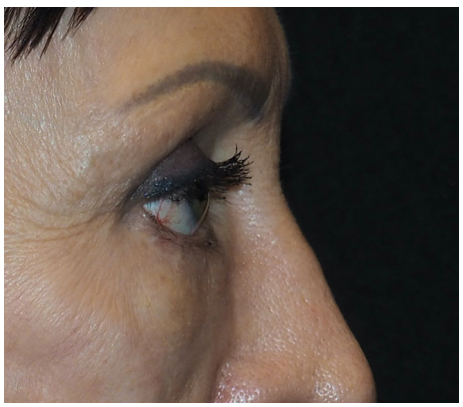

Fig. 14 Patient 4, iatrogenic LER (secondary to removal of previously injected silicone in the malar area). Lateral view, before surgery

Instead, it is the very amount of new fat cells that has the most relevance. As mesenchymal cells migrate on site, the stability of volume support is guaranteed by the local stimulation-driven proliferation of new adipocytes [38] [39], [40] which is coupled with the reduction of downward traction due to remodeling of the scar tissue [17], [18],

Fig. 15 Patient 4, iatrogenic LER (secondary to removal of previously injected silicone in the malar area). Frontal view, 52 weeks after midface lift and fat grafting to correct LER

Fig. 16 Patient 4, iatrogenic LER (secondary to removal of previously injected silicone in the malar area). Oblique view, 52 weeks after midface lift and fat grafting to correct LER

Fig. 17 Patient 4, iatrogenic LER (secondary to removal of previously injected silicone in the malar area). Lateral view, 52 weeks after midface lift and fat grafting to correct LER

[19], [20] and that stabilizes the new position of the lid margin over time [41], [42].

What better spacer than the one which is capable of both supporting the eyelid and allowing scar tissue remodeling and softening, thus promoting its elevation due to restored tissue mobility? Fat is proven to be effective for both, so this article proposes its injection for the treatment of lower eyelid retraction especially because of its dual role.

To the best of our knowledge, this is the first paper to evaluate the outcome of sole fat injection in the treatment of LER, as this procedure was widely adopted with the same aim plus personal techniques [3], [28], [29], [30], [43].

A single stage follow-up was chosen at one-year post-surgery with blind objective evaluation of surgical outcomes along with a patient assessment of both functional and aesthetic improvement [8]. The sub-population of 29 patients affected by unilateral LER allowed to perform the first case/control outcome evaluation of the technique. The average improvement of the retracted eyelid one year after fat grafting has shown to be statistically significant ($p<0.05$) in both study populations.

This study has indeed some limitations: although it presents with the higher patient numerosity to date in both general and unilateral LER population, it assesses a relatively small number of patients.

Fat grafting was performed with the unique endpoint of correcting a remaining eyelid malposition but, currently, fat harvesting is performed with heterogeneous techniques as standardized harvesting and processing methods are lacking: this considerable inter-operator and inter-technique variability even among experienced surgeons must be taken into proper consideration as it leads to a difficult assessment of the factors which determine the clinical outcome.

The amount of fat injected was detailed with respect to eyelid and malar regions, but it is difficult to clinically assess the percentage of grafted fat which is viable, and which will then support the upward position of the eyelid after 12 months.

Involutional LER does not always require fat injection, as a simpler fix exists: the cases included in the present study have been treated only to support the repositioned eyelid margin, as no scar remodeling was required. Considering the etiology of involutional LER, to restore the volume lost in the aging process could be of great value when indicated, provided that overtreatment is to be avoided if such procedures are not necessary.

The recorded outcomes along with the subjective evaluation do not allow to state a predictable amelioration of one class with respect to EGS [14]: some patients still complain about symptoms (class I) as the blurred vision is the only condition that has fully disappeared, and some patient still presents with LER (class II) after the follow-up. The use of this scale should be therefore limited to a general assessment of the study population and therefore considered anecdotal with respect to observed improvement. Nevertheless, patients might prefer minimally invasive procedures and may be willing to accept a more modest degree of improvement in return for decreased morbidity and rapid healing.

Finally, the outcomes are assessed by measurements on patient images: Authors accomplished this through a single blind measurement evaluation coupled with full-size 1:1, standardized photographs, of each patient looking straight forward in the standing position, but the reliability of head position can be questionable because a headstand was not used and it is a shared knowledge that a 15° change in head tilt can make scleral show worse or completely disappear. Still the aim of this study was to evaluate the reliability of fat injection to reposition the retracted lower eyelid rather than to fully correct a single scleral show condition.

Moreover, the images have not been standardized to a certain (11 mm) iris diameter.

Along with the validation of the presented technique, statistical analysis has shown significant difference when comparing the one-year outcome of the treated side (case) with the healthy eyelid (control): that means that LER still requires multiple approaches while the presented outcomes in the treatment of both functional and aesthetic problems demonstrate that fat injection should always be considered for its treatment. It allows effective treatment regardless of the involved lamella, and it requires a short operating time. It may be applied routinely as a stand-alone procedure or associated with other techniques, to correct extreme eyelid laxity, particularly if the 'snap test' and the 'retraction test' show significant tarsal and lateral suspension system's lack of tension.

Fat injection avoids performance of a skin incision and the consequent risk of scarring [13] and prevents any Tyndall effect or migration which are both critical as reported with other injectable agents [35].

Longer follow-up periods and a larger sample size are needed to thoroughly evaluate surgical outcomes and statistical results.

Conclusions

The authors here wish to demonstrate that fat injection provides a valuable option to address LER treatment in selected cases and that it should not be considered as just an ancillary procedure anymore.

LER functional and aesthetic rehabilitation indeed requires multiple approaches to be treated.

Both authors' statements are corroborated by the first case—control evaluation obtained in a sub-population of patients with unilateral LER.

Additional studies, with increased numerosity, are needed to confirm the presented findings.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00266-022-03114-z.

Acknowledgments The authors would like to thank Giulia Tanteri MD, an independent medical writer, who provided English-language editing and journal styling prior to submission

Funding Not applicable

Declarations

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Human and Animal Rights This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent For this type of study, formal consent is not required.

References

1. ISAPS International survey on aesthetic/cosmetic procedures https://www.isaps.org/wp-content/uploads/2019/12/ISAPS-Global-Survey-Results-2018-new.pdf; 2018, accessed March 23, 2021.
2. Patipa M (2000) The evaluation and management of lower eyelid retraction following cosmetic surgery. Plast Reconstr Surg 106(2):438–459
3. Patel A, Wang Y, Massry GG (2019) Management of post blepharoplasty lower eyelid retraction. Facial Plast Surg Clin North Am 27(4):425–434
4. Barmettler A, Heo M (2018) A prospective, randomized comparison of lower eyelid retraction repair with autologous auricular cartilage, bovine acellular dermal matrix (surgimend), and porcine acellular dermal matrix (enduragen) spacer grafts. Ophthalmic Plast Reconstr Surg. May/Jun 34(3):266–273
5. Ben Artsi E, Ullrich K, Malhotra R (2020) Submental and anterior neck originated full-thickness skin grafts for periocular procedures. Ophthalmic Plast Reconstr Surg. May/Jun 36(3):254–257
6. Mehta HK (2018) Myotarsal flap - a versatile entity for lower eyelid reconstructions. Orbit 37(3): 223-229 https://doi.org/10.1080/01676830.2018.1463547.
7. Chen Y, Al-Sadah Z, Kikkawa DO, Lee BW (2020) A modified hughes flap for correction of refractory cicatricial lower lid retraction with concomitant ectropion. Ophthalmic Plast Reconstr Surg. Sep/Oct 36(5):503–507
8. Pascali M, Avantaggiato A, Brinci L, Cervelli V, Carinci F (2015) Tarsal sling: an essential stitch to prevent scleral show in lower blepharoplasty. Aesthet Surg J 35(1):11–19
9. Pascali M, Avantaggiato A, Brinci L, Cervelli V, Carinci F (2015) Lateral canthal support in prevention of lower eyelid malpositioning in blepharoplasty: the tarsal sling. J Craniofac Surg 26(4):e339–e342
10. Pascali M, Corsi A, Brinci L, Corsi I, Cervelli V (2014) The tarsal belt procedure for the correction of ectropion: description and outcome in 42 cases. Br J Ophthalmol 98(12):1691–1696
11. Pascali M, Botti C, Cervelli V, Botti G (2017) Vertical midface lifting with periorbital anchoring in the management of lower eyelid retraction: a 10-year clinical retrospective study. Plast Reconstr Surg 140(1):33–45
12. Ben Simon GJ, Lee S, Schwarcz RM, McCann JD, Goldberg RA (2006) Subperiosteal midface lift with or without a hard palate mucosal graft for correction of lower eyelid retraction. Ophthalmology 113(10):1869–1873

13. Goldberg RA (2017) Discussion: vertical midface lifting with periorbital anchoring in the management of lower eyelid retraction: a 10-year clinical retrospective study. Plast Reconstr Surg 140(1):46–48
14. Moe KS, Linder T (2000) The lateral transorbital canthopexy for correction and prevention of ectropion. Arch Facial Plast Surg 2:9–15
15. Alghoul MS, Vaca EE, Mioton LM (2020) Getting good results in cosmetic blepharoplasty. Plast Reconstr Surg 146(1):71e–82e
16. McCord CD Jr, Shore JW (1983) Avoidance of complications in lower lid blepharoplasty. Ophthalmology 90:1039–1046
17. Klinger M, Klinger F, Caviggioli F, Maione L, Catania B, Veronesi A, Giannasi S, Bandi V, Giaccone M, Siliprandi M, Barbera F, Battistini A, Lisa A, Vinci V (2020) Fat grafting for treatment of facial scars. Clin Plast Surg 47(1):131–138
18. Piccolo NS, Piccolo MS, de Paula PN, de Paula PP, de Paula PN, Daher RP, Lobo RP, Daher SP, Sarto Piccolo MT (2020) Fat grafting for treatment of facial burns and burn scars. Clin Plast Surg 47(1):119–130
19. Pallua N, Kim BS (2020) Microfat and lipoconcentrate for the treatment of facial scars. Clin Plast Surg 47(1):139–145
20. Gentile P, De Angelis B, Pasin M, Cervelli G, Curcio CB, Floris M, Di Pasquali C, Bocchini I, Balzani A, Nicoli F, Insalaco C, Tati E, Lucarini L, Palla L, Pascali M, De Logu P, Di Segni C, Bottini DJ, Cervelli V (2014) Adipose-derived stromal vascular fraction cells and platelet-rich plasma: basic and clinical evaluation for cell-based therapies in patients with scars on the face. J Craniofac Surg 25(1):267–272
21. Kim KH, Baek JS, Lee S et al (2017) Causes and surgical outcomes of lower eyelid retraction. Korean J Ophthalmol 31(4):290–298
22. Galindo-Ferreiro A, Fernandez E, Weill D et al (2019) A web-based survey of oculoplastic surgeons regarding the management of lower lid retraction. Semin Ophthalmol 34(3):125–130
23. Tao JP, Aakalu VK, Wladis EJ et al (2020) Bioengineered acellular dermal matrix spacer grafts for lower eyelid retraction repair: a report by the American academy of ophthalmology. Ophthalmology 127(5):689–695
24. Rohrich RJ, Mohan R (2020) Preventing lateral canthal malposition in modern blepharoplasty. Plast Reconstr Surg 145(2):324e–328e
25. Botti G, Botti C, Rossati L et al (2019) "Dynamic canthopexy" drill hole canthal repositioning. Aesthet Surg J 39(12):1284–1294
26. Maffi TR, Chang S, Friedland JA (2011) Traditional lower blepharoplasty: is additional support necessary? A 30-year review. Plast Reconstr Surg 128(1):265–273
27. Pascali M, Botti C, Cervelli V, Botti G (2015) Midface rejuvenation: a critical evaluation of a 7-year experience. Plast Reconstr Surg 135(5):1305–1316
28. Riesco B, Abascal C, Duarte A et al (2018) Autologous fat transfer with SEFFI (superficial enhanced fluid fat injection) technique in periocular reconstruction. Orbit 37(3):191–195
29. Skippen B, Bernardini FP, Fezza J, Hartstein ME (2016) Autologous fat grafting for treating blepharoplasty-induced lower eyelid retraction. Plast Reconstr Surg Glob Open 4(12):e1190
30. Le TP, Peckinpaugh J, Naficy S, Amadi AJ (2014) Effect of autologous fat injection on lower eyelid position. Ophthalmic Plast Reconstr Surg 30(6):504–507
31. Shue S, Kurlander DE, Guyuron B (2018) Fat injection: a systematic review of injection volumes by facial subunit. Aesthetic Plast Surg 42(5):1261–1270
32. Schultz KP, Raghuram A, Davis MJ, Abu-Ghname A, Chamata E, Rohrich RJ (2020) Fat grafting for facial rejuvenation. Semin Plast Surg 34(1):30–37
33. Pascali M, Quarato D, Pagnoni M, Carinci F (2017) Tear trough deformity: study of filling procedures for its correction. J Craniofac Surg 28(8):2012–2015
34. Peckinpaugh JL, Reddy HS, Tower RN (2010) Large particle hyaluronic Acid gel for the treatment of lower eyelid retraction associated with radiation-induced lipoatrophy. Ophthalmic Plast Reconstr Surg 26(5):377–379
35. Xi W, Han S, Feng S et al (2019) The injection for the lower eyelid retraction: a mechanical analysis of the lifting effect of the hyaluronic acid. Aesthetic Plast Surg 43(5):1310–1317
36. Diaspro A, Sito G (2020) Hyaluronic acid for lower eyelid and tear trough rejuvenation: review of the literature. Plast Aesthet Res 7:62
37. Eto H, Kato H, Suga H, Aoi N, Doi K, Kuno S, Yoshimura K (2012) The fate of adipocytes after nonvascularized fat grafting: evidence of early death and replacement of adipocytes. Plast Reconstr Surg. https://doi.org/10.1097/PRS.0b013e31824a2b19
38. Kato H, Mineda K, Eto H, Doi K, Kuno S, Kinoshita K, Kanayama K, Yoshimura K (2014) Degeneration regeneration and cicatrization after fat grafting: dynamic total tissue remodeling during the first 3 months. Plast Reconstr Surg. https://doi.org/10.1097/PRS.0000000000000066
39. Doi K, Ogata F, Eto H, Kato H, Kuno S, Kinoshita K, Kanayama K, Feng J, Manabe I, Yoshimura K (2015) Differential contributions of graft-derived and host-derived cells in tissue regeneration/remodeling after fat grafting. Plast Reconstr Surg. https://doi.org/10.1097/PRS.0000000000001292
40. Tonnard P, Verpaele A, Peeters G, Hamdi M, Cornelissen M, Declercq H (2013) Nanofat grafting: basic research and clinical applications. Plast Reconstr Surg 132(4):1017–1026
41. Cohen SR, Hewett S, Ross L, Fischer M, Saad A, Teubel S, Delaunay F (2020) Progressive improvement in midfacial volume 18 to 24 months after simultaneous fat grafting and facelift: an insight to fat graft remodeling. Aesthet Surg J 40(3):235–242
42. Rigotti G, Chirumbolo S, Sbarbati A (2020) Commentary on: progressive improvement in midfacial volume 18 to 24 months after simultaneous fat grafting and facelift: an insight to fat graft remodeling. Aesthet Surg J 40(3):243–245
43. Pelle-Ceravolo M, Angelini M (2020) Properly diluted fat (PDF): an easy and safe approach to periocular fat grafting. Aesthet Surg J 40(1):19–33