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ORIGINAL ARTICLE
Cosmetic

Tear Trough Filler Using the Three-point Tangent Technique: Lessons from 1452 Tear Trough Applications

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Background: This study describes a novel three-point tangent technique for tear trough filler and the results from the largest series to date.
Methods: A retrospective case review was performed for all patients treated between 2016 and 2020. Patient demographics, filler details and complications were recorded. The injection technique involves using a blunt cannula to deliver filler along three linear tangents bespoke to each patient.
Results: A total of 1452 applications of filler to the orbits of 583 patients were recorded. The median patient age was 41 years (range 19–77), and 84% were women. The mean volume of applied filler at the first appointment was 0.34 mL to each orbit (range 0.1—1.5); 82% reported no complication, 10% reported swelling with a median duration of 4 weeks (range 1–52), 4.3% experienced bruising, 4.6% reported contour irregularities, and 3.3% experienced a Tyndall effect. Retrobulbar hemorrhage occurred in one patient (0.17%), which was managed immediately with no lasting visual compromise. Volume of filler injected was significantly associated with a risk of edema ($P < 0.00001$) and contour irregularities ($P = 0.012$). In total, 50% of cases of edema resolved spontaneously after 4 weeks. Filler was dissolved in 1.9% of orbits. Patients with a history of dissolving were significantly more likely to require dissolving after subsequent reinjection ($P = 0.043$).
Conclusions: The three-point tangent technique is a safe and effective method. Increasing volume of filler administered is associated with complications of edema and contour irregularities. Edema is the most common complication and resolves spontaneously in half of patients by 4 weeks. *(Plast Reconstr Surg Glob Open 2023; 11:e5060; doi: 10.1097/GOX.0000000000005060; Published online 9 June 2023.)*

INTRODUCTION

The popularity of tear trough fillers has increased in recent years as a safe and effective method to rejuvenate the eyes. Under eye bags and hollowing are common presentations, as they contribute to a fatigued appearance and represent early signs of aging, often seen in younger patients. Many patients who are predominantly volume deficient are not good candidates for blepharoplasty surgery unless adjunctive procedures such as fat grafting are performed.[1] The advantages of tear trough fillers are that they can be applied in clinic, often with minimal downtime, although there are a range of risks ranging from bruising and swelling to more serious complications, including vascular occlusion.[2,3]

Tear trough fillers are a quick and effective solution in many patients and are associated with high rates of patient satisfaction.[4] This study reports the senior author's experience in treating patients for lower eyelid rejuvenation over a 5-year period in a London-based oculoplastic practice. The aim was to describe the injection technique developed by the senior author, to describe complications, and to identify independent predictors of poor outcomes.

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Received for publication January 25, 2023; accepted March 29, 2023.

Presented at the European Society of Ophthalmic Plastic and Reconstructive Surgery Meeting, Nice, September 16, 2022.

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DOI: 10.1097/GOX.0000000000005060

Disclosure statements are at the end of this article, following the correspondence information.

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METHODS

This study was conducted in accordance with the Declaration of Helsinki. Medical records of consecutive patients treated with tear trough fillers by a single surgeon between January 2016 and June 2021 were retrospectively reviewed. Patient demographics, history of surgery or filler use, filler brand and volume, complications, and further treatment were recorded. Details of complications, including the use of hyaluronidase dissolving injections, were documented.

Three-point Tangent Injection Technique

A novel three-point tangent technique was used to treat the tear trough area. (**See Videos 1** and **2** [online], which show deconstruction of left-trough deformity into three linear tangents and the injection technique, and the right tear-trough deformity, respectively.)

Examination of the tear trough deformity was essential to delineate the problematic contours of the lower eyelid. The tear trough deformity usually extends from a point inferomedial to the medial canthus, curving inferiorly to follow the arc of the inferior orbital rim and ending inferiorly to the lateral canthus. The tear trough hollow was deconstructed into three linear components, which were bespoke to each patient. Patients were asked to look upward to accentuate the appearance of any herniated orbital fat, and tangential lines were drawn in the hollows between the herniated fat and the cheek. Typically, the first tangent extended from inferior to the medial canthus, inferolaterally to a point in line with the medial limbus. The second tangent usually had a more horizontal course, starting at the point in line with the medial limbus and extending laterally. The third tangent generally extended from a point in line with the lateral limbus and extended superolaterally along the palpebromalar groove to a point 2cm lateral to the lateral canthus (Fig. 1).

A blunt cannula method was used to deliver the filler along the three tangents. The skin was stretched and punctured deeply with a 25 gauge needle, entering the skin at 45 degrees to pass through the superficial musculoaponeurotic system. A 25 gauge, 40-mm cannula was then passed in a sub-orbicularis plane along the line of the tangent and small injection aliquots were deposited whilst withdrawing the cannula. Treatment was directed inferior to the orbital fat to smooth the junction between the prolapsed fat and the cheek. Massage was performed after injection to mold the filler and ensure the product was in the correct location. This was repeated for the second and third tangents. Resistance in passing the cannula was often experienced at the lateral tangent due to the presence of the orbicularis retaining ligament, which was overcome with controlled pressure. The cannula is passed in the coronal plane to avoid filler injection posterior to the orbital septum. After treatment, patients were advised against wearing make up for 24 hours and encouraged to resume normal activities the next day.

Data Analysis

The filler applications and outcomes were examined using descriptive statistics. An association between a binary outcome and a continuous variable (eg, filler volume) was tested using the Wilcoxon rank sum (Mann-Whitney) test. An association between a binary outcome and a binary variable (eg, previous dissolving) was tested using the chi-squared test.

Takeaways

Question: Is the novel three-point tangent technique an effective method for tear trough rejuvenation? What are the independent predictors of poor outcomes?

Findings: This technique has a lower complication rate than published studies. Higher volumes of filler injection were associated with a significant risk of posttreatment edema and contour irregularities. Half of patients with edema resolved with conservative measures by 4 weeks.

Meaning: This technique is safe and effective, and, to minimize complications, uses the minimum amount of filler necessary.

RESULTS

In total, 1452 applications of tear trough filler to the orbits of 583 patients were recorded. The median patient age at first treatment was 41 years (range 19–77), and 84% were women. An estimated 96% of patients were treated with Teoxane Teosyal Redensity 2. At presentation, 20% of patients had previous tear trough filler which was dissolved pretreatment in 13%. Dissolving was performed if patients had complications or irregularity from previous tear trough filler. In total, 16% had a history of eyelid surgery. Over the study period, 79% of patients were treated once, with 21% having repeated applications (16% twice, 3% on three occasions, and 1% had between four to seven treatments).

At the first treatment, the mean dose of filler administered was 0.34 mL to each orbit (range 0.1–1.5) (Fig. 2).

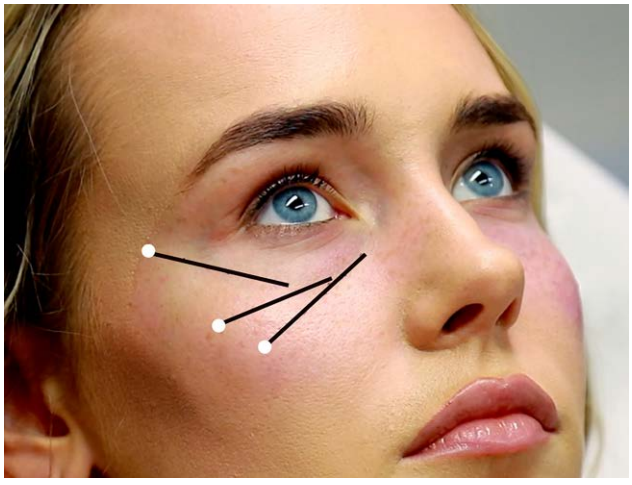

Fig. 1. The tear trough is deconstructed into three tangents. The entry point for the needle is demonstrated by a white circle, and the black line represents the planned linear deposition of the filler.

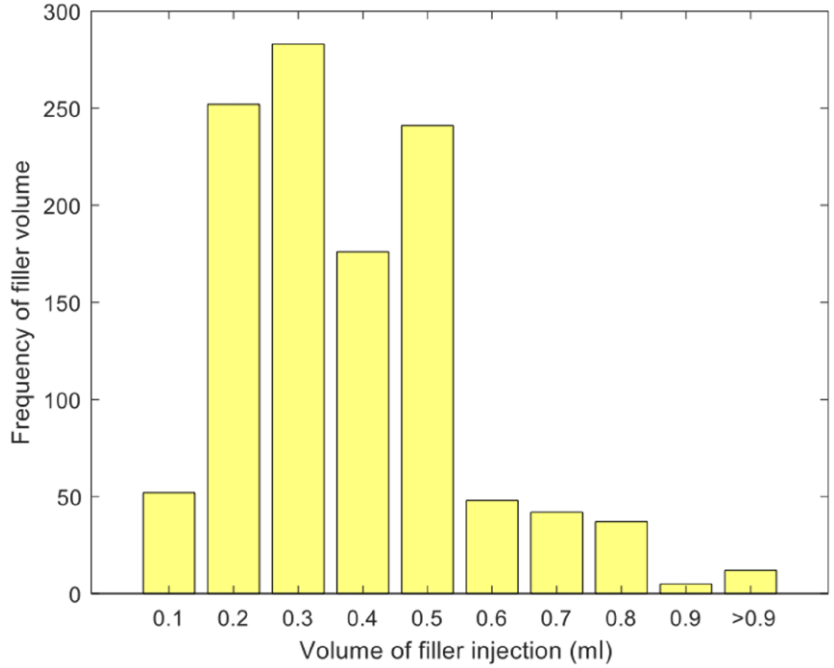

Fig. 2. Volume of filler (mL) injected per orbit at first appointment.

At subsequent appointments, the mean dose was 0.25 mL to each orbit (range 0.05–1). Figure 3 shows typical results of patients before and after treatment.

COMPLICATIONS

In total, 82% of patients reported no complication after their first treatment; 10% experienced edema with a median duration of 4 weeks (range 1–52); 4.3% experienced bruising; 4.6% reported contour irregularities; and 3.3% experienced a Tyndall effect. Edema was defined by a history of variability, which is worse in the morning and by the clinical appearance (Fig. 4). Retrobulbar hemorrhage occurred in one patient (0.17%), which was managed with an urgent canthotomy and cantholysis with no lasting visual compromise. At subsequent visits, when

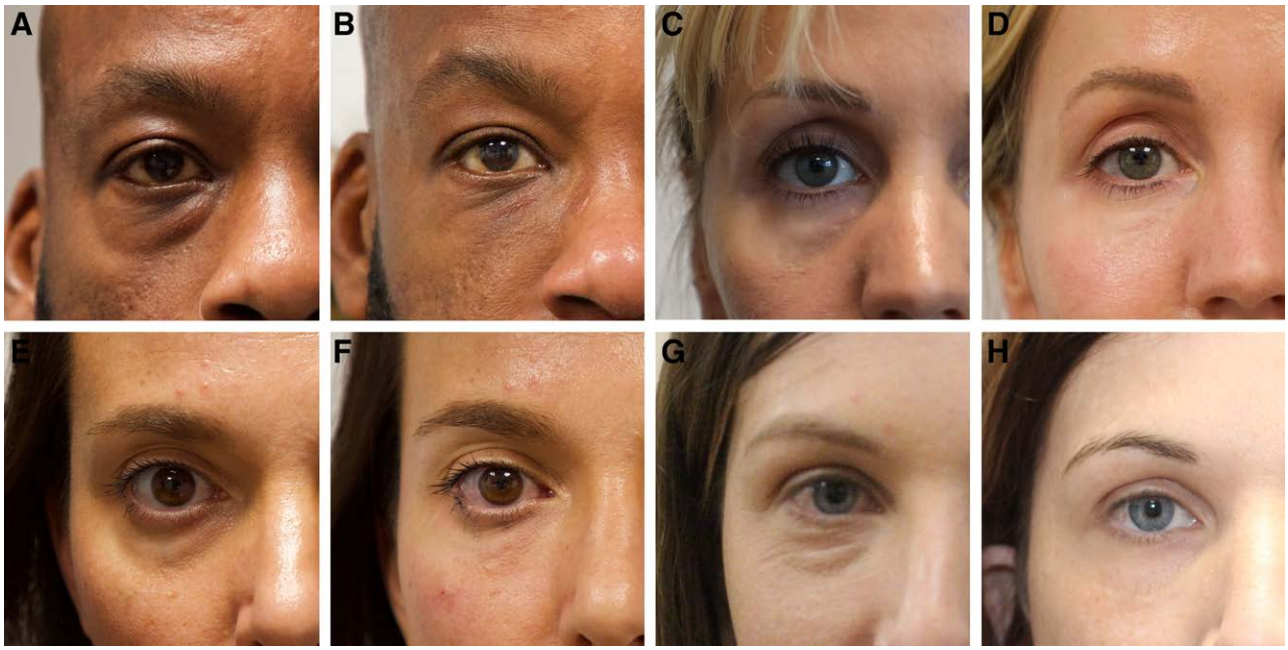

Fig. 3. Pretreatment (A, C, E, G) and posttreatment (B, D, F, H) photographs using the three-point tangent technique.

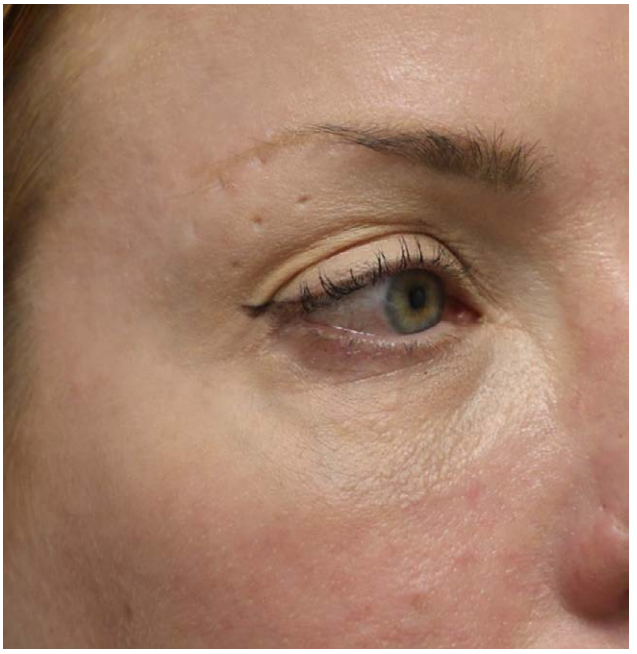

Fig. 4. Patient photograph showing edema 4 weeks after tear-trough injection requiring dissolving.

patients attended for top-up injections, 84% of patients reported no complication, 13.1% experienced edema, 1.7% experienced bruising, 2.3% reported contour irregularities, and 1.7% experienced a Tyndall effect.

Table 1 compares the complication rate of our study with a large systematic review by Trinh et al of 1545 patients who underwent dermal fillers for tear trough rejuvenation.[5]

Edema and Filler Volume

Edema was the most common complication accounting for 10% after the first filler injection. Univariate analysis was performed to identify independent predictors of edema and the volume of filler administered was highly significant ($P < 0.00001$, Fig. 5A). As the injection volume increased, the risk of edema increased, and an injection volume over 0.3 mL was significantly associated with edema ($P < 0.0001$).

Contour Irregularities and Filler Volume

Similarly, the volume of filler injected was strongly associated with a higher risk of contour irregularities ($P = 0.012$, Fig. 5B).

Table 1. Comparison of Complication Rate with Systematic Review by Trinh et al[5]

Complications	Current Series(n = 583)	Trinh et al[5](n = 1545)
Edema	10.0%	24%
Bruising	4.3%	19%
Contour irregularities	4.6%	8%
Tyndall effect	3.3%	6%
Retrobulbar hemorrhage	0.17%	0%

Edema Resolution Time

Edema occurred in 58 patients: unilateral swelling in 61% and bilateral in 39%. In 84% (n = 49) of cases, the edema resolved with conservative measures, whereas in the remaining 16% (n = 9), the filler was dissolved. Of the 49 cases of edema which resolved with conservative measures, 25% resolved within 3 weeks or less, 50% resolved within 4 weeks or less, 75% resolved within 10 weeks or less, and 100% within a year (Fig. 6). There was no apparent relationship between volume of filler injected and time until the resolution of edema ($P = 0.78$).

Dissolving

Eleven patients (1.9%) underwent dissolving with hyaluronidase after their first filler injection in the clinic. The decision and timing of when to dissolve was following a discussion regarding the risks and benefits and the likelihood of resolution with simple measures including massage. Of these patients, four had presented with edema and had undergone a dissolving session before reinjection with filler. A chi-squared test showed that a history of dissolving was significantly associated with the requirement for dissolving after the first filler injection in clinic ($P = 0.043$).

The indication for dissolving was as a result of edema in eight patients, contour irregularities in two, and a combination of both in a final patient. In addition, one patient was initially pleased with the results of the tear trough filler but developed edema after surgical blepharoplasty 7 months later, which resolved with dissolving. One of the 122 patients who attended for a top-up (0.8%) underwent dissolving.

DISCUSSION

In youth, there is a smooth convexity as the lower eyelid extends inferiorly to the cheek. With advancing age, a double convexity occurs with formation of the nasojugal fold or tear trough deformity medially and the palpebromalar groove or malar fold laterally. Loss of volume in the midface, including loss of facial fat, deficient sub-orbicularis oculi fat at the level of the nasojugal fold, and descent of the malar fat pad results in prominence of the orbital rim and exposure of the infraorbital fat pads.[6] In addition, age-related elongation of the orbital retaining ligament and orbital septum laxity allows orbital fat to prolapse anteriorly.[6] These factors, combined with the inelasticity and "tethering effect" of the medial portion of the tear trough ligament, contribute to the formation of the tear trough deformity.[6,7]

A range of injection techniques have been described for the treatment of this area with filler and most commonly reported are serial puncture, cross-hatching, retrograde linear threading, and microbolus techniques.[5] Our studies use retrograde linear threading but along three tangents specific to each patient. A blunt cannula is used to reduce tissue trauma and the risk of complications.[8,9] The benefit of our technique is that the curved nasojugal and palpebromalar groove are deconstructed into linear

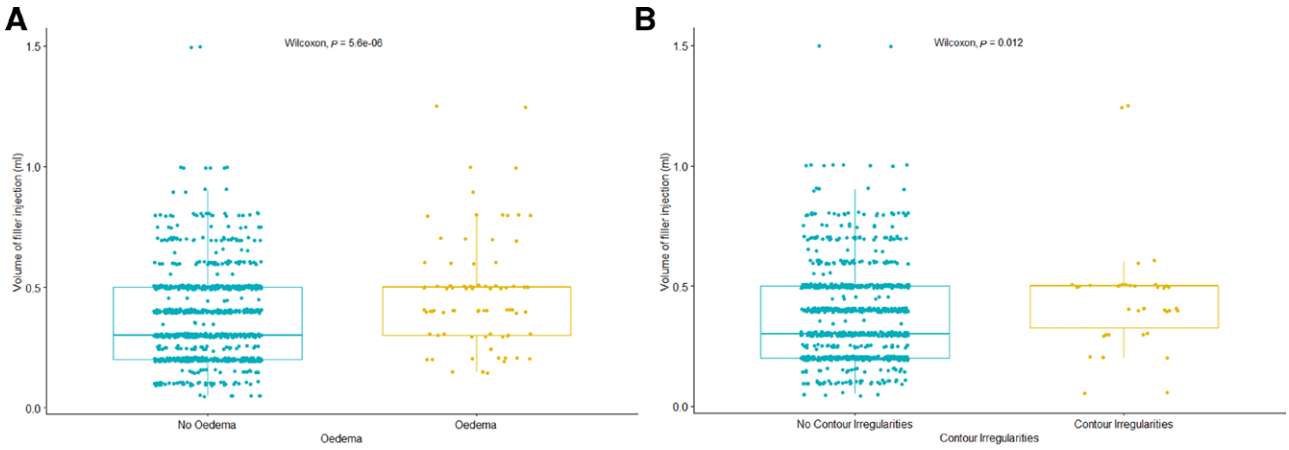

Fig. 5. Box plots showing the association between volume of filler injected and complications. A, Volume of filler injected is significantly associated with the risk of posttreatment edema ($P < 0.00001$). B, Volume of filler injected is significantly associated with the risk of post-treatment contour irregularities ($P = 0.012$).

components. This allows for retrograde linear threading, following the course of a straight cannula, creating minimal collateral tissue damage and enabling filler placement in the correct position.

The depth of filler placement varies amongst studies, and a recent systematic review reported that most techniques involved placing filler pre-periosteally, deep to the orbicularis oculi muscle (OOM) and anterior to the inferior orbital rim.[5] Only two studies described subcutaneous placement of the filler with reported high improvement rates[10,11] The results of anatomic studies investigating the vascular anatomy in the tear trough region have been inconclusive. A study of computed tomographic contrast-enhanced images of 72 fresh-frozen white body donors found that the angular vein travels deep to the OOM.[12] A study of 156 contrast-enhanced computed tomographic images of healthy, procedure naive white patients showed that the angular artery traveled in 82.7% of the patients superficial to the OOM.[13] In contrast, a recent real-time ultrasound study concluded that no major arterial vessel was observed within the tear trough, and the angular artery did not seem to travel deep to the OOM but within the muscle itself.[14] Our placement of filler sub-orbicularis serves to provide an

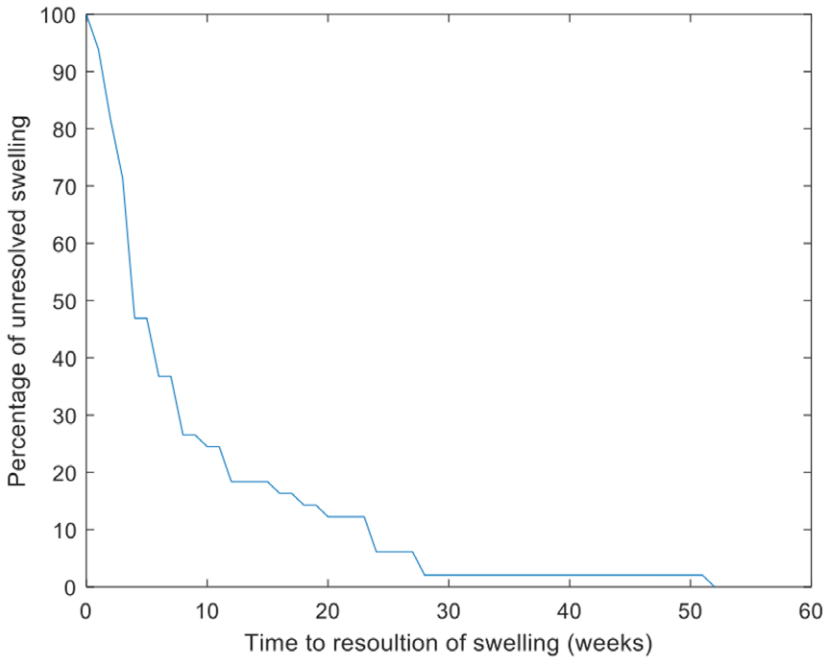

Fig. 6. Kaplan-Meier curve shows the time to resolution of edema with conservative measures.

even spread of filler material and to prevent the occurrence of visible lumps or Tyndall effect without increasing the risk of vascular occlusion.

In our series, 84% of patients were women, and the mean age was 42 years, which is comparable with reported series.[4,15] As a specialized oculoplastic unit, many patients present with complications from filler injected by other practitioners. In total, 20% of patients had previous filler to the tear trough and this was dissolved pretreatment in 13%. This reflects our practice to dissolve any remaining filler before proceeding with a new treatment to prevent the risk of complications from layering filler.

The commonest filler brand used was Teosyal PureSense Redensity II (manufactured by Teoxane Laboratories) which was used in 96% of applications. This is specifically designed for periorbital treatment and is composed of cross-linked and noncross-linked hyaluronic acid of nonanimal origin, a dermo restructuring complex (supplemented phosphate buffer containing eight amino acids, three antioxidants, two minerals, and vitamin B6) and lidocaine 0.3%. The hyaluronic acid concentration (15 mg/g) is less than that of conventional fillers, which reduces the risk of posttreatment edema as the gel absorbs less water.[15]

In this study, the mean dose of first application of filler was 0.34 mL to each orbit, which is lower than the 0.47 mL reported by a large systematic review of 1545 patients in 19 studies.[5] Edema was the commonest complication in our study, reported in 10% of patients and lower than the 24% reported by Trinh et al.[5] It is often difficult to differentiate between overfill and swelling, but all patients in this study defined as having edema reported a history of significant variability, being worse in the morning, which is pathognomonic of an edematous etiology resulting from the hydrophilic nature of the filler and diurnal changes in body fluid distribution. Our study found that that injection volumes over 0.3 mL were significantly associated with an increased risk of swelling. Other factors that may affect the visibility of edema include the depth of injection and location, but, as all injections in this case series were similar, the key influence was volume. Contour irregularities were recorded in 4.6% of our cases, which is lower than 7.57% recorded by Trinh et al.[5] The present study showed that higher volumes of filler were significantly associated with edema and contour irregularities. The lower filler doses in our study could account for the lower rate of edema and contour irregularities observed.

Bruising was reported in just 4.3% of our cases when compared with 19% by Trinh et al.[5] This could be explained by our minimally traumatic technique, which uses a blunt cannula and deposits filler along a linear tangent rather than feathering in multiple directions, which can cause injury. When comparing needle-based and cannula injection techniques, bruising has been shown to be more common in needle techniques.[9]

There were no complications of vascular occlusion or visual loss, but one patient developed a retrobulbar hemorrhage, despite the use of a blunt canula. This was identified immediately by the injecting surgeon and dealt with promptly with canthotomy and cantholysis. The patient experienced no lasting visual compromise, and the canthotomy site healed spontaneously without the need for repair. This rare complication has not been described in the literature and may be under-recorded due to reporting bias. This highlights the requirement for those undertaking periorbital injections to be able to recognize and manage visual-threatening complications immediately. It is essential that appropriate emergency referral pathways are in place if in-house expertise is not available.

Of the patients who developed edema after first filler injection, 84% resolved with conservative measures such as massage. We observed that 50% of these cases resolved within 4 weeks, and the remaining 50% resolved up to a year later. This suggests that if a patient presents with a complication of swelling, they can be advised to wait 4 weeks before considering intervention, and the survival pattern of edema resolution may be very effective at supporting patient decisions regarding weighing the use of filler dissolving injections.

Filler was dissolved with hyaluronidase in 1.9% of cases, less than the 5.15% recorded by Trinh et al.[5] The decision regarding dissolving was based upon the patient's choice after being informed of all the risks and benefits. The requirement for dissolving was used as a threshold outcome for patients sufficiently dissatisfied with the results of the injection. As such, this is an important clinically relevant threshold of the degree and severity of the swelling. Patients with a history of dissolving for edema were significantly more likely to require dissolving after treatment with filler in our clinic. This reflects the need to adequately counsel patients when dissolving filler, that re-treatment with filler may be associated with the same problems that they presented with and require further dissolving. Edema and contour irregularities may be in part due to constitutional patient-factors which would explain why previous problems can predispose to developing complications in the future, and great caution should be taken when considering fillers in these patients.

Autologous fat transfer is an alternative treatment providing a more permanent solution for the tear trough deformity but carries significant risks. Short- and long-term fat survival is variable and can lead to volume under- or overcorrection. A wide range of harvesting, fat preparation, and injection techniques exists, which can contribute to contour irregularities.[16] Autologous fat is the filler type most likely to cause irreversible visual loss and stroke caused by retrograde intravascular fat injection, which could reflect the use of larger volumes, larger syringes, and higher extrusion pressures.[17]

The novel three-point-tangent injection technique is a safe and systematic approach to managing the tear trough deformity, with 83% of patients experiencing no complications. This study reports the results from the largest series to date on tear trough fillers and highlights that smaller doses of filler reduce the risk of edema and contour irregularities. We recommend using a cannula technique and limiting the volume of filler injections to 0.3 mL where possible, to avoid poor outcomes. Limitations include the retrospective design and that we did not grade the severity

of the tear trough, which could be a biasing factor. The vast majority of our patients were treated with Teosyal® PureSense Redensity II, and the generalization of this technique with other filler products is unclear.

The rates of adverse effects using this technique were lower than a large systematic review for all parameters, apart from retrobulbar hemorrhage with an incidence of 0.17%, highlighting the need for practitioners to be adequately trained to deal with this vision-threatening complication.

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DISCLOSURES

Dr Sieun Lee receives funding from Precision Imaging Beacon, University of Nottingham. All the other authors have no financial interest to declare in relation to the content of this article.

ACKNOWLEDGMENT

We thank Karen Papier, Alison Shalson, Mandy Saffer, Louise Leventhal, and Julie Davidson for support in preparation of the article.

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