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ORIGINAL ARTICLE
Cosmetic

Widening Aging Eyes and Ending Outdoor Tearing with Retrobulbar Injections of Dermal Fillers

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Background: As people age, the intraorbital fat may diminish and palpebral fissures may narrow, causing the eyes to increasingly tear outside in cold weather. As the bulbus recedes from the conjunctiva, a "wind trap" is formed in the lateral corner of the eye. This wind trap appears to irritate the adjacent lacrimal gland. In this article, an 84-year-old patient experienced annoying outdoor tearing despite having undergone three tarsal strip canthopexies during the past 20 years.
Methods: Retrobulbar injections of 3.5-mL high-viscous dermal fillers (Bellafill or Radiesse) pushed the eyeballs forward, aligned the bulbus with the conjunctiva, and closed the wind trap behind the lateral canthus. Magnetic resonance imaging confirmed the filler material in the posterior lateral corner of the orbit.
Results: The effect was immediate: the patient's constant outdoor tearing had resolved after the first treatment of his senile enophthalmos. In addition, the narrow palpebral fissure had widened by 2 mm and rejuvenated his aging eyes.
Conclusions: An eyeball that has receded with age can be pushed forward with a retrobulbar injection of a long lasting dermal filler to reattach to the eyelids.
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INTRODUCTION

The annoying tearing in fresh air experienced by older people due to functional impairment in senile enophthalmos (Fig. 1A) has not been addressed to date. The standard of care is tarsal strip canthopexy. However, if this technique is not effective, retrobulbar injections may be a safe and effective alternative. The injected filler will push the sunken bulbus forward and realign it with the conjunctiva to close the gap in the lateral corner of the eyelids. An open canthus acts as a "wind trap" (Fig. 1B).

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This obvious gap between conjunctiva and eyeball is due to the shrinkage of intraorbital fat in aging patients with consequent receding of the bulbus, causing the senile enophthalmos.[1,2] Upper and lower eyelids are fixed between the inner canthus at the nasal bone and the Whitnall tubercle inside the lateral orbital wall (Fig. 2A). Tightening of aging, loose eyelids does not close this wind trap but rather lowers the central part of the lower eyelid, similar to shortening the latitude on a world globe. Simply tightening an already loose lower eyelid in an older patient will be a temporary fix; the eyelid will loosen again because its connective tissue is worn out.

Retro-orbital injections of dermal fillers or autologous fat grafts are common procedures to correct the position of sunken eye prostheses in anophthalmic orbits.[3] Solid implants or injectables are the gold standard of corrective measures in functional but dislocated eyes after "blow-out-fracture" or tumor resection[4,5] (Fig. 3).

The Tearing Problem

Ophthalmologists relate tearing most often to the so-called dry eye syndrome[6] or ocular surface disease, which is not always well understood by other physicians. Aging eyes have a narrow eyelid gap that prevents the cornea from drying out. In aging eyes, tearing is especially heavy in high humidity or during rain when hypothetical "evaporation" is impossible. In our patient, eye drops containing antibiotics, corticosteroids, or hyaluronic acid (HA) did not inhibit or decrease the hypersecretion of tears, called epiphora[7] (Fig. 1A).

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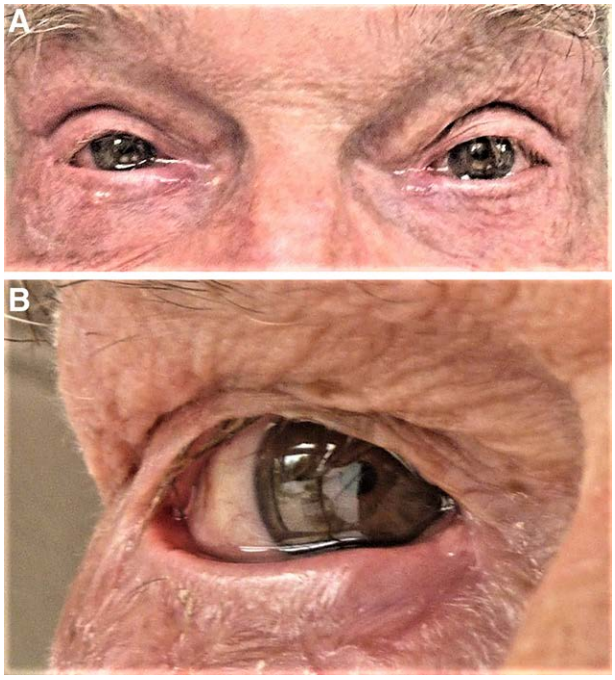

Fig. 1. "Swimming eyes" in old age. A, The slow loss of intraorbital fat has led to narrowing of the palpebral fissures. B, "Wind trap" of the right senile eye opens when looking to the left.

Takeaways

Question: What else can be done when three tarsal strip tightening operations have failed to relieve extreme outdoor tearing in old age?

Findings: The reason for the severe outdoor tearing is the atrophy of the intraorbital fat and thus the receding of the bulbus. An open "wind trap" in the lateral corner of the eye allows irritating wind to the lacrimal gland.

Meaning: The injection of any long-lasting dermal filler pushes the eyeball forward so that the eyelids align to the bulbus again. The outdoor tearing stopped immediately and the narrow palpebral fissure widened significantly.

METHOD

Our male patient, an 84-year-old plastic surgeon, had upper and lower blepharoplasty with removal of fat from all three compartments at age 54. At 65, he began experiencing severe lacrimation when outdoors. A simple wedge excision of 5 mm from the lower tarsus did not align the lateral lower eyelids or stop the tearing. His lower eyelids were tightened three times with lateral tarsal strips by two experts in plastic and one in oculoplastic surgery. Finally, the canthal ligament was pulled through a drill hole in the lateral orbital wall above the Whitnall tubercle, also with only short-term success.

Findings

The lower eyelids were in their anatomical place, the tear drainage to the nose was open, and the muscles of the lower eyelid were intact. A 5-minute Schirmer test at room temperature revealed 30-mm tears, a clear negative result. Regardless, the tearing was attributed to a dry cornea, although the retracted eyeballs were persistently immersed in tears (Fig. 1A). The lateral canthus retracted from the lateral eyeball and formed a small pocket, which

The Cosmetic Problem

In advanced age, bony atrophy of the orbit leads to an increase in total orbital volume, mainly in its lateral lower corner, which further facilitates the receding and sinking of the bulbus[8] (Fig. 4). Since common oculoplastic techniques failed to reattach the conjunctiva to the globe, the attachment of the globe at the conjunctiva was attempted by pushing it forward with filler injections.

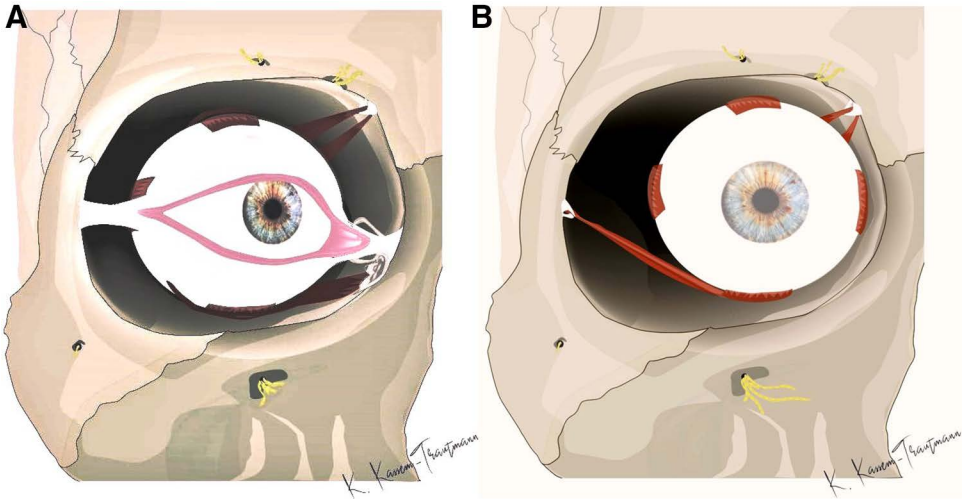

Fig. 2. Content of the orbit. A, The palpebral tendons and tarsal plates are fixed between bones. They loosen in patients with senile enophthalmos and cause a gap behind the lateral canthus. B, All structures of the eyeball–except the inferior oblique muscle–are fixed in the upper inner quadrant. The lower lateral quadrant is filled with padding fat. (Original figure adapted from: YouTube—bones of the orbit; www.youtube.com/watch?v=JYE9-Pq-Yc0.)

Fig. 3. Blow-out fracture. A, Sunken but functioning left eye after blow-out-fracture. B, After infrabulbar injection of 2 mL Artecoll.

we call the wind trap (Fig. 1B). Since the lacrimal gland is located at a close distance of 1 cm above this wind trap, the nonadhesion of the lateral conjunctiva with the eyeball may be the cause of tearing similar to a foreign body on the conjunctiva.

Anatomy

The lateral orbital wall does not parallel the inner wall but leads in an oblique direction toward the optical canal and the superior orbital fissure in the back (Fig. 5). The optic nerve enters the orbital cavity together with the ophthalmic artery through its optic canal medially in the upper inner half of the orbit. The inferior orbital fissure runs below the optic canal toward the exit of the infraorbital nerve below the pupil. It contains the infraorbital nerve, artery, vein, and the zygomatic nerve.

These structures cannot be damaged with a blunt cannula if its tip remains on the orbital floor in a straight vertical direction 5 mm lateral from the midline. There, the tip reaches the oblique lateral wall at least 10 mm lateral from the inferior orbital fissure. The globe is protected from below by both the inferior rectus and oblique muscle. There are no connecting structures between the eyeball with its surrounding muscles and the orbital floor or lateral wall (Fig. 2B).

Ophthalmic surgeons routinely use a "retrobulbar block" to provide anesthesia for most of the orbit, especially in cataract surgery, with a very low incidence of complications. This injection provides akinesia of the extraocular muscles by blocking the optic and oculomotorius nerve. In addition, movement of the globe is blocked and sensory anesthesia of the ciliary nerves anesthetizes conjunctiva, cornea, and uvea.

Injection Technique

For the injection of a dermal filler containing 0.3% lidocaine into the orbit, local anesthesia is not necessary. To avoid bruising at the entrance site of the cannula, a local anesthetic with epinephrine can be injected into the skin and orbicularis muscle 5 mm lateral of the exit of the infraorbital nerve.

For added safety measures, at the first injection of viscous HA, Restylane Lyft, was used to be eventually dissolved by hyaluronidase injections in the case of overcorrection or complications. Later, high-viscous particulate fillers such as Radiesse and Bellafill and monophasic HA (Varioderm) were used for comparison.

A stab incision was made 5 mm lateral of the exit of the infraorbital nerve, just above the orbital rim, and a blunt 25G-canula of 5 cm length was introduced (Fig. 6A). Should the insertion of the orbital septum in the orbital rim be too tight, the perforation may be attempted a few millimeters above, where the septum is thinner. From there, the blunt tip of the cannula scratched forward on the periosteum of the orbital floor.

Reaching the end of the oblique posterior wall and floor in a depth of approximately 4 cm (Fig. 6B), a bulk of 2 mL Restylane Lyft was slowly injected. The patient felt comfortable and experienced the filling of the orbit only as slight pressure. If the patient feels an unpleasant

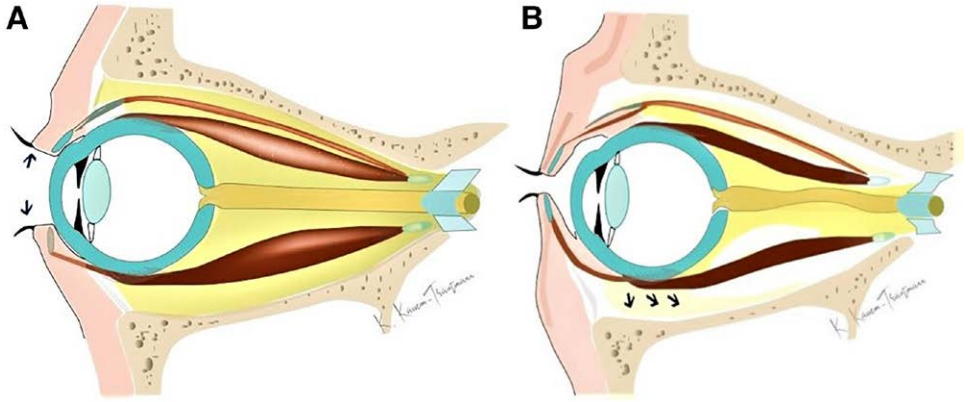

Fig. 4. Atrophy of the orbital fat. A, Young eyelids rest on the bulbus due to the pressure from behind. B, Old eyelids stick out from the eyeball because of its retraction.

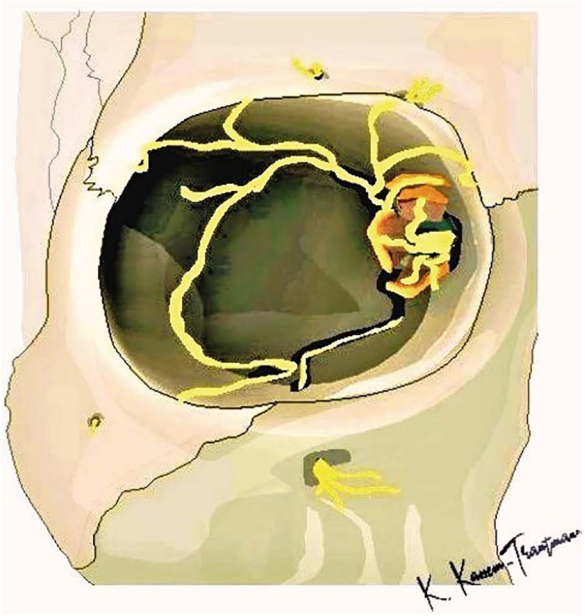

Fig. 5. Aging orbital bones with zygomatico-temporal nerve: bony atrophy of orbital bones increases orbital volume mainly in the lower lateral quarter. Filling this vacuum with a bulking agent pushes the bulbus forward.

pressure, one can stop earlier. The injector saw the globe coming forward as the wind-trap inside of the lateral canthus slowly closed.

To distribute the filler material comfortably, the patient was asked to move his eyes in all directions. Temporary double vision occurred between the two injections but resolved when the bulk of the injectable found its final place in the retro-orbit. After the injections, the patient remained in the office for a while until possible double vision had disappeared and possible hemorrhage was excluded. Swelling of the lower eyelids was noted for a few days. Cold compresses may provide comfort.

RESULTS

The immediate effect of the injection was satisfactory, as tearing in the cold decreased to about 70% and the palpebral fissure appeared to be 1 mm more open. (Fig. 7A and B). For a 100% positive result (Fig. 7C), another 1.5 mL Bellafill was injected behind the left eye and 1.5 mL Radiesse (for comparison) was injected behind the right eye at 3 months (Fig. 8A).

During injection of Radiesse, a small soft nodule of Restylane appeared in the right lower lid but resolved following a 0.5-mL (=75 I.E.) hyaluronidase injection. After this experience with a less viscous biphasic HA product, we are reluctant to recommend common HA fillers for intraorbital injections. Looking for a high-viscous HA-based filler with 33 mg/mL HA, 1 mL monophasic Varioderm,[9] was injected off-label as a fourth retrobulbar bulking product at 10 months, when light tearing reoccurred after the first Restylane filling was probably absorbed. One has to be cautious of overfilling the orbit: a total injected volume of 3-mL long-lasting filler appears to be enough to prevent extrusion of smaller filler surplus.

High-viscous Radiesse (Table 1) or a permanent filler containing PMMA-microspheres (Bellafill) will be preferable, because their exact location can be detected by magnetic resonance imaging (MRI) or computed tomography (CT) (Fig. 9). Any filler may be used for a second injection since we are not aware of any interactions or hyperimmune reactions between two different filler products.[10]

Proof of Filler Location

CT and MRI are the most useful radiological investigations for enophthalmos. Soft-tissue views can illustrate fat atrophy, fibrotic changes and the nature and extent of any orbital lesions or injected implants, especially when they were deposited as one single bulk. However, neither CT nor MRI revealed the location of the injected HA. The MRI of the patient at 3 months showed the injected PMMA-microspheres (Bellafill) and

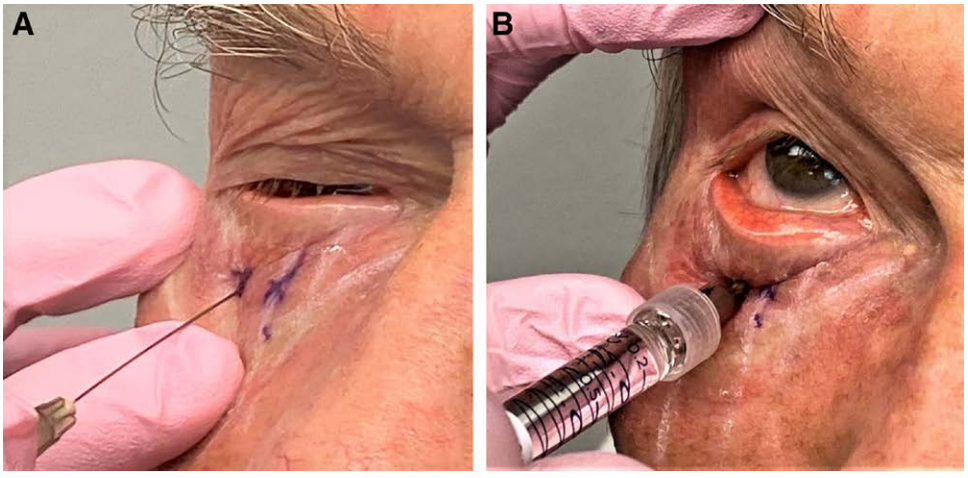

Fig. 6. Retrobulbar injections. A, The 25G cannula is inserted 5 mm lateral of the infraorbital nerve. B, The cannula is forwarded in the sagittal direction scratching on the orbital floor without pain until its tip reaches the posterior wall.

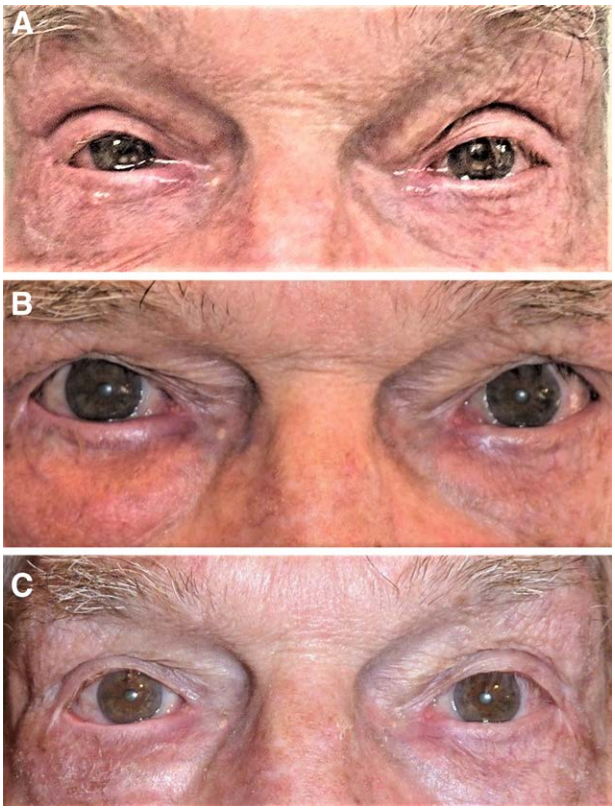

Fig. 7. Follow-up photographs. A, The patient before retrobulbar filling with 2 mL HA. B, At 3 months, a small wind trap remains. To achieve a 100% result, an additional 1.5 mL Bellafill or Radiesse was injected. C, At 9 months, there is no tearing and a wide palpebral fissure.

the calcium-microspheres (Radiesse) behind and lateral of the left and right eyeball (Fig. 8).

An ultrasound scan may be readily available and a much cheaper first-line-examination in the diagnosis of orbital tumors and structures located beyond the muscular cone. In the paraocular technique, the ultrasound beam will omit the globe but show particulate fillers as tumors and HA as cysts displacing the eyeball. We ourselves have no experience with ultrasound examination of the orbit; however, the borders of a particulate injectable and its exact location can easily be detected by an experienced ophthalmologist.[11]

The further course of our patient was uneventful and no negative feelings were reported: the tearing in open air was significantly diminished (Fig. 9A). No "crusty eyes" were noted in the morning and the open lateral wind trap was closed as the eyeball became reattached to the lateral conjunctiva. The palpebral fissure immediately widened from 8 to 10 mm and remained so at 12 months follow-up (Fig. 9B). Interestingly, the palpebral fissure was wider at 6 then at 3 months. The ingrowing connective tissue into particulate implants became a "living implant" by pushing the clumped microspheres of Bellafill apart and increasing its volume.[13]

DISCUSSION

Senile or Involutional Enophthalmos

In reconstructive surgery of the orbit, we do not hesitate to correct the broken bony walls, to insert implants,[4] or to inject all kinds of fillers[12] to bring the globe into a position which repairs double vision, ptosis, or aesthetic deformities. Why should we not try to solve the tearing problem of many older people with retrobulbar injections of particulate injectables?

Choosing the best method for correction of enophthalmos is a challenge for the surgeon. The eye is surrounded by very delicate muscles, and the orbit contains a myriad of sensory, motor, and sympathetic and parasympathetic nerves in addition to a plexus of veins and arteries. However, the whole intraorbital content, fat muscles and globe, can be pushed forward as the cannula remains on the bony orbital floor and the injection remains slowly on the lateral side of the globe (Fig. 2B). An orbit has a volume of about 30 mL; 3-mL fillers are 10% to compensate for its age-related loss of fat.

Many deformities of the orbital content have been described over the years, but few have been treated. Guyuron et al[2] assessed the effects of orbital aging in 21 patients over a period of 6–24 years with facial photographs. Nineteen of the 21 patients had relative enophthalmos at the second time point, and all 19 of the patients had eyelid ptosis. Their study demonstrated the

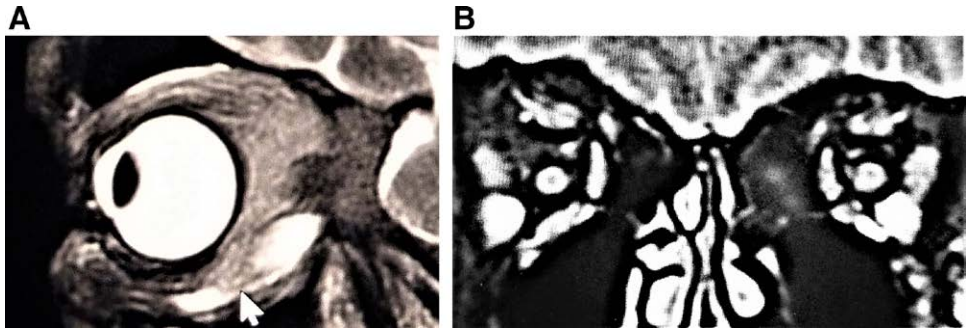

Fig. 8. MRI of the orbits at 3 months. A, Radiesse appears as a white stripe lateral and below the right bulbus (arrow). B, Bellafill and Radiesse are recognizable as round white bulks lateral and behind the bulbus.

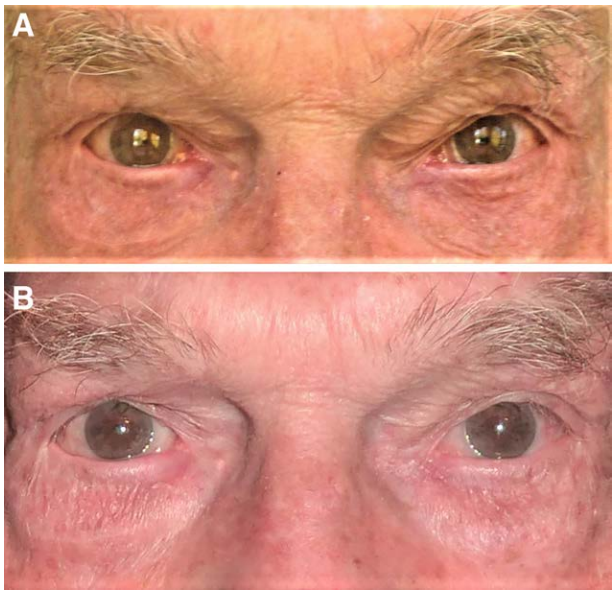

Fig. 9. Late results. A, At 10 months, Restylane had probably been absorbed and light tearing recurred; 1.5 mL Varioderm was added retro-orbitally on both sides. B, One year after resorption of the former temporary fillers and the last injection of permanent Bellafill in both orbits, there is still no recurrence of tearing or nose running in the cold.

development of age-related enophthalmos and eyelid ptosis, which is commonly undetected.

Direct widening of the palpebral fissure has been requested by Korean women with typical slanted Asian eyes. Through a small incision in the canthal angle, the lower lateral retinaculum is released, freed, and fixed at the inner periosteum of the lower orbital rim, lowering the lateral eyelid margin significantly.[13]

The only known literature reference of a resolution of tearing through a block implant referred to a 21-year-old woman with a history of infantile hydrocephalus who presented with bilateral persistent tearing.[14] Examination revealed marked bilateral enophthalmos, poor lower eyelid apposition to the ocular surface, and patent nasolacrimal systems. The insertion of a mesh and block implant within the subperiosteal space of the orbital roof resulted in the correction of enophthalmos, improved lower eyelid apposition, and resolution of tearing.

Different Dermal Fillers and Bulking Agents

HA Injections

The optimal filler has not been determined in this first attempt to align the conjunctiva by pushing the eyeball forward. Different brands of HA gels are supposed to last for 6–9 months and are available in every practice.[12] Little, however, is known about their elasticity and viscosity, that is, their behavior as a bulking agent. It is to be expected that a larger bolus of highly viscous HA will lose little volume during the first year, as it is only slowly degraded from the edge by hyaluronidases and macrophages.

A prospective case series reviewed clinical, photographic, and radiologic records of 16 patients with anophthalmic or enophthalmic orbits, who underwent volume augmentation by injection with HA gel in the intraconal and extraconal posterior orbits.[15] At follow-up after 12 months, 15 of 16 patients were still satisfied with their cosmetic results.

Another series[16] involved 21 patients with enophthalmos and sunken superior sulcus resulting from soft-tissue volume loss occurring with aging, previous surgery, trauma, or phthisis bulbi. Injections of Restylane in the retrobulbar area and in the sunken superior sulcus improved enophthalmos by 1.3±0.8 mm. Three patients with Parry-Romberg syndrome and significant enophthalmos of 4 mm received a total of eight retrobulbar injections of the Sub-Q filler. Enophthalmos was reduced to 1 mm and lasted up to 2 years.

Particulate Fillers

The most common particulate filler Radiesse contains microspheres from calcium hydroxylapatite suspended in carboxymethyl-cellulose, which are slowly absorbed over 1–1.5 years.[12] Radiesse was injected for correction of postenucleation or evisceration socket syndrome (PESS).[17] In 15 individuals, the mean amount of preoperative relative enophthalmos measured by Hertel exophthalmometry was 4 mm. An average reduction of 2.4 mm of enophthalmos per 1.5-mL filler was achieved. Complications included anterior migration of filler, a peribulbar hemorrhage, and orbital discomfort.

Non-absorbable and, therefore, permanent fillers are Artecoll in China or Bellafill and Permanique in the United States. In Brazil, two similar PMMA-products, Biossimetric and Linnea Safe, are approved and widely used. They remain in the place where they are injected because the body's ingrowing connective tissue fixes the microspheres immediately.[12]

These five PMMA-microspheres-containing bulking agents are converted by ingrowing vascularity to living implants which will bleed when cut. The fear that foreign body granuloma could develop after PMMA injections[10] can be countered—so far, granulomas only develop after intradermal or superficial subcutaneous injections, not in deeper tissue or epiperiosteal deposition. The most sensitive organ for immunological reactions remains the dermis.

In the case of overcorrection or lasting diplopia, particulate fillers and modern bulking agents have one disadvantage over HAs: they cannot be dissolved by enzymes but must be surgically removed from the orbit.

Viscosity and Elasticity

All filler products can be quantified by their elasticity, which describes how the filler is able to retain shape when a force is applied. Viscoelastic properties depend either on their molecular weight, their concentration in fluid HA, on the percentage of crosslinking, or on the number of particles suspended in a certain carrier (biphasic). High elasticity fillers are monophasic, firmer to palpate, and more contour stable.

For retrobulbar injections, a firmer product is a better choice since more fluidal ones may spread on the orbital floor without pushing the eyeball forward. Gel cohesion data show that products with the lowest cohesive properties were HAs with 14–18 mg/mL. Those with the highest cohesive properties were the monophasic HA-products, CPM_{BB} with 48 mg/mL HA and $XPRES_{RF}$ with 46 mg/mL HA.[18]

The choice falls on the off-label use of these two highly cohesive HAs in the United States, or high-viscous Varioderm from Germany, which contains 27 mg/mL HA.[9] Another off-label alternative to test might be Urolastic, a two-component self-curing bulking agent from silicone which hardens within a few minutes after injection.[19] If necessary, it could be removed as one solid implant from behind the globe in a rather easy operation.

Table 1 demonstrates the properties of modern HA products[18] and particulate fillers such as Bellafill and Radiesse. It is interesting how the addition of 0.3% lidocaine lowers the viscosity of Radiesse by diluting its water-soluble carrier, carboxymethyl-cellulose.

Autologous Fat Grafting

In senile enophthalmos, intraorbital fat has slowly atrophied, and its replacement with autologous fat therefore appears logical. However, the effectiveness and durability of fat injections cannot yet be predicted; a certain percentage "take," and a larger percentage lodge as oily cysts.

Orbital periosteum and the muscle fascia of the eye are not as good vascularized as subcutaneous fat. Therefore, cannula-based orbital fat grafting has not gained the status of standard of care because of perceived low likelihood of success. However, oil cysts may serve the same purpose as a bulking agent over a certain time. Of a total of 10 subjects enrolled, six subjects showed volume improvement at 1 year, and four showed variable diminution over 2–5 years.[20]

To evaluate the effects of orbital injection of fat, the treatment of 10 posttraumatic enophthalmos patients with intact or removed globes was tested.[21] The fat was injected into the muscular cone in the retrobulbar or retroimplant space using a 14-gauge needle. Seven patients required multiple injections. Another late enophthalmos was corrected with retrobulbar lipofilling of 3.2 mL fat with a satisfying increase in exophthalmometry measurements.[22]

A Chinese team reported recently on 30 patients after traumatic enophthalmos, who underwent retro-ocular injections of fat globules.[23] All patients needed several fat injection sessions.

In an animal experiment,[24] the right eye orbital volume of 10 rabbits was augmented with autologous fat injected into the retrobulbar space. Right globe position showed a mean increase in eye proptosis of 3.4 mm at postoperative day 1 and of 0.9 mm at 11 weeks postoperatively in comparison with the left globe position. Histologic analysis showed both revascularized and necrotic areas of fat.

Fat injections in general are becoming more and more sophisticated since the stimulating effect of stem and regenerative cells within the stromal vascular fraction of fat has been identified.[25] Therefore, composite fat grafts with the stromal fraction are presented as a new concept, as are "biofilling" and "biocontouring." After contact with the host, these additional cells stimulate angiogenesis at the histologic level and may be the future of fat grafting.[25]

Table 1. Elasticity and Viscosity of Different Dermal Fillers (See Also Fagien et al[18])

Filler Name	Elasticity (G′)	Viscosity (G″)
Artecoll, Bellafill, PMMA	2400	1530
Varioderm 27 mg/mL	1536	519
Radiesse	1407	350
Radiesse + lidocaine	554	143
Restylane Lyft	545	119
Juvederm Voluma	274	93

Potential Risks

The first thing that comes to mind is the risk of ophthalmic artery embolism. This is a known and serious complication following accidental filler injections into the facial or supratrochlear artery when a pointed needle is used and not moved during injection. The ophthalmic nerve is encased by six eye muscles and lies in the upper inner opposite corner of the orbit. In Figure 2B, the lateral inferior corner of the orbit is free of vessels or nerves extending to the eyeball. The only artery on the orbital floor is the fine infraorbital artery, which arises from the maxillary artery and thus has no connection to the ophthalmic artery. This artery and nerve have to be avoided by a puncture 5–10 mm lateral from their infraorbital exit. Any retro-orbital injection should not be done through a pointed needle but a cannula 25G, or better, 23G × 1.5 inches—as used in most filler injections today.

The orbital wall is lined with periosteum and the intraorbital fat compartments are surrounded by a fine fibrous capsule. When advancing a blunt cannula on the orbital floor, one easily gets between these two sheaths. The only danger in the lateral half of the lower orbit would be injection of the filler into the intraorbital fat. This has no effect on the desired bolus of filler in the orbit: whether in the fat or outside the fat makes no difference. A particulate permanent or semi-permanent filler will always remain deposited behind the bulb. We do not recommend HAs as a filler material because they do not form a round bolus, but spread out due to lack of viscosity and are more likely to leak once through the entrance hole in the orbital septum.

Potential Adverse Events

Six retrobulbar injections were given through a blunt 25G cannula in less than a minute each without any complications. The patient felt slight intraorbital pressure but no pain. Nevertheless, all possible side effects must be considered, including pain or nerve pain after rapid or misguided injection, permanent sensory issues due to compression, retrograde leakage of the filler into the lower eyelid, double vision and permanent diplopia after uneven injection, intraorbital bleeding after pricking a blood vessel (special caution is advised in patients taking blood thinners), infections or late inflammatory reaction to the filler, or even loss of vision due to nerve compression.

CONCLUSIONS

In senile involutional enophthalmos and sunken eye syndrome with pathological tearing caused by nonattachment of the lower eyelid at the eyeballs, tightening of the lower eyelid with tarsal strip canthopexy is the standard of care. However, this technique reaches its limits in cases of severe recession of the eyeball. Our first case of orbital volume augmentation with dermal fillers shows that pushing the eyeball forward to achieve attachment to the full lower eyelid margin can stop or diminish chronic tearing. At present, long-lasting fillers such as Radiesse or permanent fillers such as Bellafill appear to be preferable to high-viscous HA fillers or autogenous fat.

This simple injection technique is safe in the hands of experienced eye surgeons and may be considered as a last resort if canthopexies have failed in the treatment of extreme epiphora. The detached and therefore open lateral canthus (wind trap) can be reattached and closed with different injectables, if possible, using ultrasound control.

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PATIENT CONSENT

Showing the patient's eyes in figures is permitted by the corresponding author, who is the patient.

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