Dandy criteria for diagnosis of IIH, an absence of obstruction of the ventricular system and no other cause for elevated intracranial pressure are required.[9] Additionally, Virchow's triad for thrombosis overlaps with characteristics of IIH, where her morbid obesity and illness directly affected her prolonged hospital period of immobility.[10] The hypercoagulable state known to be associated with COVID-19 infection additionally predisposes the patient to an elevated risk of thrombotic event. With the patient's MRI/MRV denoting CVST in the setting of immobility and underlying COVID-19 infection, CVST is the favored diagnosis, and a clinically separate diagnosis of IIH is less likely. The partial cranial nerve 3 palsy accompanying the bilateral 6th nerve palsies may also be explained by CVST. It has been reported in multiple cases of CVST[11] and is most likely due to a vascular pressure gradient that leads to edema and dysfunction of multiple cranial nerves.

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Orbital Inflammation Following COVID-19 Vaccination

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Abstract: **Three patients presented with periorbital swelling, pain with extraocular movements, and binocular diplopia 1–4 days after receiving an mRNA Coronavirus Infectious Disease-19 (COVID-19) vaccine (BNT162b2, Pfizer/BioNTech; mRNA-1273, Moderna). All patients had a normal afferent function, unilateral limitation of extraocular motility, proptosis, and periorbital inflammation. Neuroimaging of the orbits with contrast revealed inflammation and enlargement of extraocular muscles in 2 cases and the lacrimal gland in 1 case. In all 3 cases, an extensive infectious and inflammatory laboratory work-up was unremarkable and signs and symptoms of orbital inflammation rapidly improved to complete resolution after treatment with high-dose oral prednisone. This is the first reported series of orbital inflammation occurring shortly after administration of the COVID-19 vaccine. Clinicians may consider an inflammatory postvaccine etiology as an alternative to presumed idiopathic diagnosis in such cases.**

Ophthalmic sequelae associated with Coronavirus Infectious Disease-19 (COVID-19) infection have been well described, with the most commonly reported findings consisting of conjunctivitis, neuroretinitis, uveitis, and fungal orbital cellulitis and few reports of COVID-19-associated orbital inflammation. Ocular adverse events following COVID-19 vaccination are less common, with 4 reports of orbital disease: 2 cases of superior ophthalmic vein thrombosis, 1 case of Tolosa-Hunt syndrome, and 1 case of acute thyroid eye disease.[1,2] The authors report 3 cases of orbital inflammation occurring within days of the BNT162b2 mRNA (Pfizer/BioNTech) or mRNA-1273 (Moderna) COVID-19 vaccine which is suggestive of an association. This case series was performed in compliance with the Declaration of Helsinki and Health Insurance Portability and Accountability Act regulations.

CASE PRESENTATION

Case 1

A 68-year-old man with no known autoimmune or rheumatologic history presented with binocular diplopia, pain with extraocular movements, and periorbital swelling 4 days after receiving the second dose of COVID-19 vaccine (BNT162b2 mRNA, Pfizer/BioNTech). He denied any other systemic infectious or inflammatory symptoms. On presentation, his visual acuity was 20/20 in each eye and intraocular pressures (IOP) were normal. There was no relative afferent pupillary defect (rAPD) or dyschromatopsia. The OS was noted to have marked limitation in supraduction and 3 mm of relative proptosis (Fig. 1A). The remainder of his ophthalmic examination was unremarkable. Orbital CT with contrast revealed inflammation of the left superior oblique muscle (Fig. 1B). A laboratory workup including complete blood count (CBC), basic metabolic panel (BMP), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), angiotensin-converting enzyme (ACE), lysozyme, IgG subclass, antinuclear antibody (ANA), antineutrophil cytoplastmic antibody (ANCA), double-stranded DNA antibody (DS-DNA), thyroid-stimulating hormone (TSH) with reflex, Sjogren's antibodies (SS-A/SS-B), rheumatoid factor (RF), quantiferon-gold, fluorescent treponemal antibody-absorption (FTA-ABS), rapid plasma reagin (RPR), and Epstein Barr virus antibodies (EBV) was unremarkable.

Case 2

A 33-year-old woman presented with binocular diplopia, periorbital swelling, and pain with extraocular movements, as
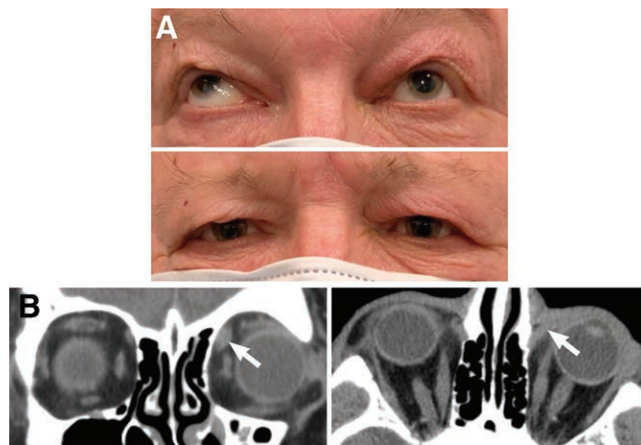
FIG. 1. **A,** External photograph demonstrating mild left-sided periorbital edema and erythema with limitation of supraduction. **B,** CT orbits with contrast, coronal (left) and axial (right) sections demonstrating focal enlargement of the anterior aspect of the left superior oblique muscle (arrows). CT, computed tomography.
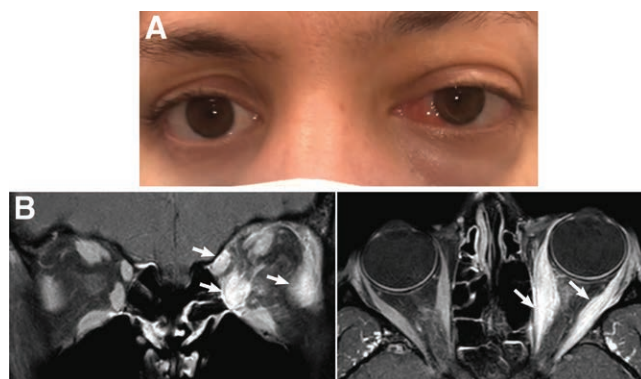

FIG. 2. **A,** External photograph demonstrating left periorbital edema and erythema with focal conjunctival injection and chemosis over the left medial rectus insertion. **B,** MRI orbits with contrast, with T1 post-contrast fat suppressed coronal (left) and axial (right) sections demonstrating enlargement and enhancement of the left medial rectus and lateral rectus, and superior oblique muscles with associated fat stranding and proptosis (arrows). MRI, magnetic resonance imaging.
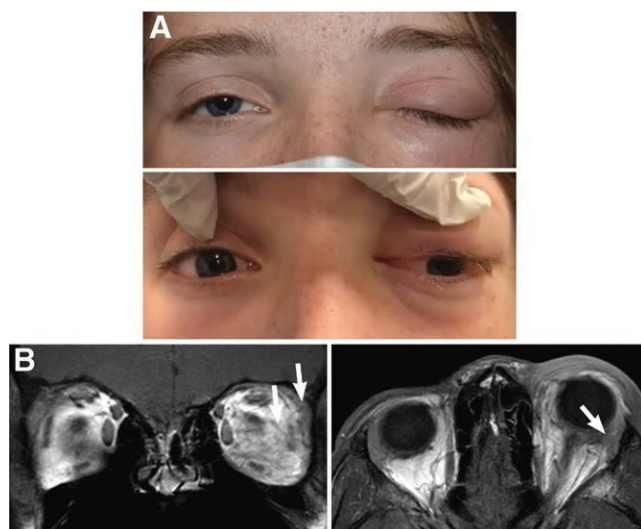

FIG. 3. **A,** External photographs demonstrating periorbital edema, erythema, and conjunctival injection and chemosis. **B,** MRI orbits with contrast, with T1 fat-suppressed coronal (left) and axial (right) sections demonstrating left preseptal edema, intraconal fat stranding, enlarged lacrimal gland, and globe proptosis (arrows). MRI, magnetic resonance imaging.

well as mild myalgias and headache 1 day following the second dose of COVID-19 vaccine (mRNA-1273, Moderna). This patient had a previous similar episode of orbital inflammation 1 day following an influenza vaccination 1 year prior, which was successfully treated at the time by an outside physician with a high dose oral corticosteroid to complete resolution after an unrevealing extensive lab workup. Her examination at the time of presentation revealed visual acuity of 20/15 in each eye and normal IOP. There was no rAPD or dyschromatopsia. The OS demonstrated moderate limitation of abduction and 3 mm of proptosis, as well as conjunctival injection and chemosis (Fig. 2A). The remainder of the ophthalmic examination was unremarkable. MRI of the orbits with contrast revealed inflammation and enlargement of the left medial and lateral rectus, and superior oblique muscles (Fig. 2B). A laboratory work-up including CBC, BMP, ESR, CRP, ACE, lysozyme, IgG subclass, ANA, ANCA, DS-DNA, TSH with reflex, SS-A/SS-B, RF, quantiferon-gold, FTA-ABS, RPR, EBV, and Lyme screen with reflex was unremarkable.

Case 3

A 13-year-old boy with a history of recurrent idiopathic orbital inflammation which was quiescent for over a year presented with left periorbital swelling, erythema, and pain 1 day after his first dose of COVID-19 vaccine (BNT162b2 mRNA, Pfizer/BioNTech). Prior episodes of orbital inflammation were triggered by upper respiratory tract infections. Examination at the time of presentation revealed visual acuities of 20/20 in the OD and 20/40 in the OS, normal IOP, and no rAPD or dyschromatopsia. The OS was noted to have moderately restricted supraduction and abduction, 3 mm of proptosis, conjunctival injection and chemosis, and left upper and lower eyelid edema and erythema (Fig. 3A). The remainder of the ophthalmic examination was unremarkable. MRI of the orbits with contrast revealed recurrent orbital inflammation with left lacrimal gland enlargement and intraconal fat stranding in a similar pattern to prior episodes of orbital inflammation, but not noted on surveillance MRI of the orbits several weeks prior (Fig. 3B). A laboratory workup including CBC, BMP, ESR, CRP, ACE, lysozyme, IgG subclass, ANA, ANCA, TSH, thyroxine (T4), complement C3, complement C4, and Lyme screen with reflex was unremarkable.

In all 3 cases, an extensive infectious and inflammatory laboratory work-up was unremarkable. Signs and symptoms of orbital inflammation improved promptly in all cases after initiation of treatment with 60 mg of oral prednisone. All patients achieved complete resolution after prednisone taper over the span of 1 month and have remained in remission at 6–11 months follow-up after completion of treatment. The third patient's taper was prophylactically maintained at 20 mg of oral prednisone at the time of his second vaccination dose, without recurrent inflammation or subsequent COVID-19 infection. A rapid corticosteroid course starting at 20 mg of oral prednisone will be initiated 2 days prior to his third vaccination to minimize the risk of recurrent inflammation.

DISCUSSION

Many studies have reported ophthalmic manifestations associated with COVID-19 infection, with some reporting ocular involvement in up to one-third of patients.[3,4] Described ocular findings vary from conjunctivitis most commonly, to neuro-retinal disease, fungal orbital cellulitis, episcleritis and keratitis, among others. In these reports, ocular signs and symptoms are most commonly presented during the active, symptomatic disease course of COVID-19.

Orbital involvement concomitant with COVID-19 infection appears to be a less common ophthalmic manifestation. Of the reported cases involving the orbit, the most document fungal rhino-orbital infection. In the largest such study, Sen et al. reported 2,826 cases of COVID-19-associated rhino-orbital-cerebral mucormycosis, with orbital involvement in 72% of patients and onset of symptoms most commonly within 14 days after diagnosis of COVID-19.[5] Orbital inflammation associated with COVID-19 remains far less common, with only 6 reports in the literature to date including orbital myositis, orbital inflammatory disease, optic perineuritis, and dacryoadenitis.[6–11] In contrast to the most of COVID-19-associated ocular manifestations, systemic symptoms of COVID-19 were either absent or mild in each of these cases.

To date, there are numerous case reports describing ocular adverse events following COVID-19 vaccination.[1,2,12] These reports include corneal graft rejection, eyelid edema and rash, episcleritis and scleritis, anterior uveitis, Vogt-Koyanagi-Harada Syndrome, white dot syndromes, central serous chorioretinopathy, retinal vascular occlusions, acute retinal necrosis, ischemic optic neuropathy, optic neuritis, cranial nerve palsies, Tolosa-Hunt syndrome, thyroid eye disease, and superior ophthalmic vein thrombosis. Similar to orbital involvement concomitant with COVID-19 infection, an orbital disease associated with COVID-19 vaccination remains far less common than other ophthalmic adverse events. To our knowledge, this is the first report documenting orbital myositis and dacryoadenitis following the COVID-19 vaccination. The onset of symptoms within 1 week of vaccination is in line with previous literature. The exact immune-mediated mechanism by which COVID-19 targets orbital tissue remains yet to be elucidated. However, inflammation following vaccination suggests an immunological process targeting orbital tissue rather than direct viral infiltration, which has been hypothesized by some to be the underlying mechanism of COVID-19 infection-associated ophthalmic diseases.

Although rare, orbital myositis or dacryoadenitis may occur within days after administration of the COVID-19 vaccine. If no underlying etiology is identified after extensive workup, an inflammatory postvaccine etiology may be considered as an alternative to a presumed idiopathic diagnosis. As in 2 of the 3 reported cases, a history of orbital inflammation may be a predisposing factor. Though causation cannot be proven, the temporal relationship between vaccination and onset of orbital inflammatory symptoms in the reported cases, in combination with an extensive unrevealing workup, is highly suggestive of an association. Ophthalmologists should be aware of this possible association to appropriately counsel patients, particularly those with underlying orbital inflammatory conditions, of signs and symptoms that may warrant early examination. Prophylactic treatment with corticosteroid prior to vaccination may be considered for patients with previous orbital inflammation. However, it remains yet to be elucidated whether such treatment may diminish vaccine efficacy.

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Tear Trough Malar Implant Penetrating Lacrimal Sac Causing Lacrimal Obstruction and Epiphora: Case Report and Review

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Abstract: **Tear trough implantation may be associated with a number of well-reported complications. To our knowledge, penetration of the lacrimal sac has never been reported as a complication of malar or tear trough implants. We report a case of lacrimal sac penetration discovered at the time of endoscopic dacryocystorhinostomy surgery in a patient who developed epiphora soon after the tear trough implant was placed.**

Despite wide availability of tissue fillers, the use of alloplastic biomaterials as tear trough implants remain a popular surgical alternative due to their ability to provide long-lasting volume enhancement. Two of the most popular implant materials used today are polyethylene and silicone.[1] Alloplastic implants in general, while benefitting from predictive outcomes and permanency, may be associated with complications and require a steep learning curve to master their use. Reported complications include infection, malposition, and localized nerve injury.[1–3]

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To our knowledge, penetration of the lacrimal sac has never been reported as a complication of malar or tear trough implants. We report a case of lacrimal sac penetration discovered at the time of endoscopic dacryocystorhinostomy (DCR) surgery in a patient who developed epiphora soon after the tear trough implant was placed. This report adhered to the ethical principles outlined in the Declaration of Helsinki. Patient consent was obtained for the use of all included photographs and imaging.

CASE REPORT

A 60-year-old male presented to the eye clinic with a 6-year history of bilateral epiphora but worse in his OS that developed immediately after bilateral tear trough implants were inserted under the care of another surgeon, 6 years ago (Fig. 1A). Tear trough implantation was preceded by preoperative imaging (CT with 3D reconstruction) for planning and customization of the implant (Fig. 1C). The patient underwent insertion of what he was informed was a "bespoke" silicone implant (Fig. 1B). The exact type of implant was a 3D Accusan-890 (Implantech Associates, Inc.). Surgery was performed via a transconjunctival/lateral canthotomy approach, and he developed epiphora within 2 weeks after surgery, which progressively worsened. He was wiping his eyes at least every hour outdoors (every 2 hours indoors) with inner spill over but no discharge. His symptoms were causing a nuisance and affecting multiple activities including reading, work, and driving.

On examination, visual acuity was 6/7.5 OD and 6/6 OS. On lacrimal syringing, there was partial patency to syringing on the right but on the left, there was complete nasolacrimal duct obstruction with no mucocele and normal canaliculi. Ocular surface was normal, and spontaneous blink was complete, although the patient was noted to have a small conjunctival flap posterior and inferior to his left lower punctum, likely related to his previous implant surgery. Nasal endoscopy was normal apart from a narrow left nasal passage and deviated septum. The patient was recommended for left powered endonasal (DCR)[4] with septoplasty and intubation.

At the time of surgery, after opening the lacrimal sac and exposing the lacrimal sac mucosa and internal ostium, a foreign body was found to be penetrating the lateral wall of the sac, a few millimeters inferior to the internal ostium (Fig. 2A). There was also scarring of the adjacent mucosa. The foreign body, identified to be part of the patient's tear trough implant, was trimmed at the lacrimal mucosa (Fig. 2B). The operation was completed with lower eyelid canalicular intubation with a Mini Monoka tube. Small pledgets of Spongostan absorbable hemostatic Gelatin Sponge soaked in triamcinolone 40 mg/ml were placed over the flaps to help hold them in place immediately, postoperatively.

The patient was reviewed 3 weeks, postoperatively, and reported a 95% improvement in epiphora. He remains patent to syringing at 6 months follow up with no evidence of any residual silicone implant seen in the nasal cavity. Due to success of the left side, the patient underwent right powered endonasal (DCR) with intubation. During this operation, the lacrimal sac was noted to be normal in appearance, showed no sign of breach and surgery was carried out in the routine fashion.

DISCUSSION

To our knowledge, penetration of the lacrimal sac has not been reported as a complication of malar or tear trough implantation. We report a case discovered at the time of endoscopic DCR in a patient who presented to us with epiphora that developed soon after the initial tear trough implantation. It should be considered as