Original Article

Craniomaxillofacial Trauma & Reconstruction

Craniomaxillofacial Trauma & Reconstruction
2020, Vol. 13(1) 32-37

DOI: 10.1177/1943387520906004
journals.sagepub.com/home/cmt
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Nasolacrimal Obstruction Following the Placement of Maxillofacial Hardware

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Abstract

Purpose: This article reviews cases of nasolacrimal obstruction (NLO) secondary to maxillofacial hardware placement.

Methods: A retrospective review was performed at a single institution from 2012 to 2017 of patients with NLO following maxillofacial reconstruction. The study was approved by the Institutional Review Board of the University of California, San Francisco, adhered to the tenets of the Declaration of Helsinki, and was Health Insurance Portability and Accountability Act compliant. Patients were included if external dacryocystorhinostomy (DCR) confirmed previously placed maxillofacial hardware as the primary contributor to lacrimal outflow obstruction and had at least 3 months of follow-up.

Results: Of 420 patients who underwent external DCR, 6 cases of implant-related NLO were identified. The mean age was 47.3 $\pm$ 9.6 years and 66.7% of patients were male. All patients presented with epiphora and 50% also had chronic dacryocystitis. Patients had prior maxillofacial hardware placement for paranasal sinus tumors (66.7%) or facial fractures (33.3%). In addition to external DCR, all patients had revision or removal of implants that were impeding lacrimal outflow by 2 mechanisms: (1) an orbital implant impinging the lacrimal sac or nasolacrimal duct (NLD) and/or (2) maxillofacial screws placed into the bony NLD or nasolacrimal fossa. Five of the 6 patients (83.3%) had complete resolution of symptoms and patency of the nasolacrimal system at their last follow-up visit (range 3-30 months).

Conclusion: NLO secondary to hardware placement, though infrequent, is underreported. Two mechanisms of hardware-induced NLO were encountered in this case series. Specific attention to nasolacrimal anatomy at the time of maxillofacial reconstruction may help minimize implant-induced NLO.

Keywords

nasolacrimal obstruction, epiphora, orbital implants, orbital reconstruction, facial reconstruction, dacryocystorhinostomy

Introduction

Orbital and microplate fixation hardware are commonly used to obturate oculofacial defects and restore functional anatomy.[1] These defects frequently arise from trauma or neoplasm resection.[2]

Nasolacrimal obstruction (NLO) implies blockage along any location of the lacrimal system. Acquired NLO and subsequent epiphora can be caused by a variety of mechanisms including trauma, neoplasms, and inflammation.[3] Post-traumatic NLO has been reported after maxillary or naso-orbito-ethmoidal (NOE) fractures with an incidence ranging from 14% to 68.4%.[4-9] NLO in these cases has classically been attributed to bony displacement, mucosal swelling, or scarring.[3-9]

Epiphora also commonly follows sinonasal tumor management. Apart from the role of radiotherapy and chemotherapy in the pathogenesis of NLO in this setting, surgical removal of the lacrimal drainage system may be required for adequate tumor clearance.[10-12] In head and neck cancers, the incidence of orbital wall involvement ranges from 30% to 80% depending on the site of origin, histology, and aggressiveness of the neoplasm.[13-15] Transection of the nasolacrimal duct (NLD) is often required during maxillectomy for tumors involving the sinonasal tract, with rates of postoperative epiphora as high as 63%.[11,16] Although the pathogenesis of epiphora in nasal and paranasal sinus tumors

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Table 1. Demographic and Clinical Characteristics.

Case	Age	Gender	Laterality	Clinical Presentation	Indication for Primary Surgery	Prior Radiation	Prior Stenting	Implant Position	Status of Lacrimal Drainage System	MMC during DCR	Outcome	Follow-Up (month)
1	80	Male	Left	Chronic dacryocystitis + epiphora	Fronto-ethimoidal SCC	Yes	Yes	Medial wall implant anterior to PLC	Resected LS	No	Success	12
2	25	Female	Right	Epiphora	Orbital floor osteoblastoma	Yes	Yes	Floor/medial wall implant anteromedial to LSF	Transected LS	No	Success	30
3	32	Male	Left	Chronic dacryocystitis + epiphora	NOE fracture	No	Unknown	Medial wall implant anterior to PLC + screws in NLD canal	Intact	No	Success	6
4	29	Male	Left	Epiphora	Facial fracture	No	Unknown	Floor implant medial to LSF + screws in LSF	Intact	No	Success	6
5	46	Male	Left	Chronic dacryocystitis + epiphora	Maxillary SCC	Yes	No	Floor/medial wall implant anteromedial to LSF	Resected LS	Yes	Failure	24
6	72	Female	Left	Epiphora	Maxillary ACC	Yes	Yes	Floor implant anteromedial to LSF	Transected NLD	Yes	Success	3[a]

Abbreviations: ACC, adenocystic carcinoma; DCR, dacryocystorhinostomy; LS, lacrimal sac; LSF, lacrimal sac fossa; MMC, mitomycin C; NLD, nasolacrimal duct; NOE, naso-orbito-ethmoidal; PLC, posterior lacrimal crest; SCC, squamous cell carcinoma; ZMC, zygomaticomaxillary complex.
[a]Confirmed by telephone that patient continued to be epiphora-free at post-operative month 24.

is multifactorial, the contribution of orbital and microplate fixation hardware has rarely been reported.

To our knowledge, only 3 case reports in the English language have described NLO secondary to maxillofacial hardware which had been implanted during facial fracture repair.[17-19] Given limited reporting on hardware-related NLO, we aim to describe the mechanisms by which hardware can induce epiphora, as well the management of this finding in a series of consecutive patients.

Epiphora of all the patients in this series was treated via external dacryocystorhinostomy (DCR). Standard external DCR involves removal of bone from the lacrimal sac fossa (osteotomy), followed by the creation of an anastomosis between the medial wall of the lacrimal sac and nasal cavity mucosa. In this series, DCR also involved the removal of orbital hardware obstructing the passageway between the lacrimal system and nasal cavity.

Methods

A retrospective chart review was performed on all cases of external DCR procedures by authors R.C.K. and M.R.V. from June 2012 to December 2017. The study was approved by the Institutional Review Board of the University of California, San Francisco (Study number 17-22740) and adhered to the tenets of the Declaration of Helsinki. The study was conducted in full compliance with the Health Insurance Portability and Accountability Act of 1996.

Patients were included if, during DCR, previously placed orbital or microplate fixation hardware were identified as the primary contributor to NLO. Patients were excluded if follow-up was less than 3 months. Clinical notes, operative reports, and imaging of eligible patients were reviewed for demographic information, contributing factors, surgical history, and postoperative outcomes. Post-surgical success was defined as resolution of symptoms and patency of the nasolacrimal system on irrigation at the last follow-up visit.

Results

Of 420 patients who underwent external DCR during the study period, 6 cases of implant-related NLO were identified. The mean age was 47.3 $\pm$ 9.6 years (range 25-80 years) and 67% of patients were male. Epiphora was present in all patients and 50% of patients also had chronic dacryocystitis. Patients had prior maxillofacial reconstruction with hardware placement for paranasal sinus tumors (67%) or facial fractures (33%). All patients with paranasal sinus tumors had partial resection or transection of the nasolacrimal system. Table 1 summarizes the baseline characteristics of the study patients. In addition to revision or removal of the obstructing implant, all patients underwent an external DCR. Two of the 6 patients had a mitomycin C (MMC) (0.5 mg/mL)-soaked cottonoid placed

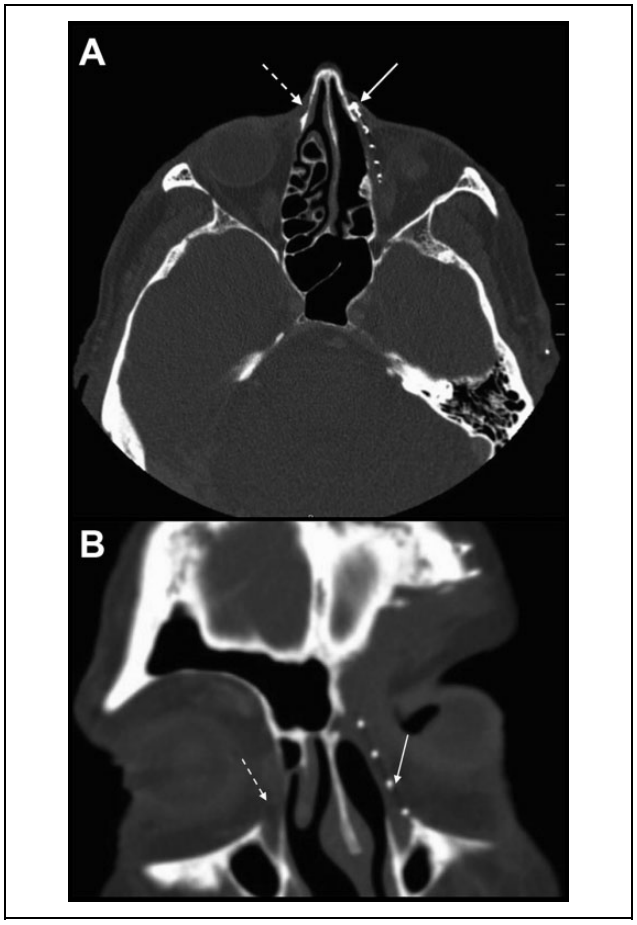

Figure 1. Case 1: CT scan of the orbit on axial (A) and coronal (B) cuts showing an orbital implant (solid arrow) overlying the post-tumor resection osteotomy. The unobstructed lacrimal sac fossa is seen on the contralateral side (dashed arrow). CT indicates computed tomography.

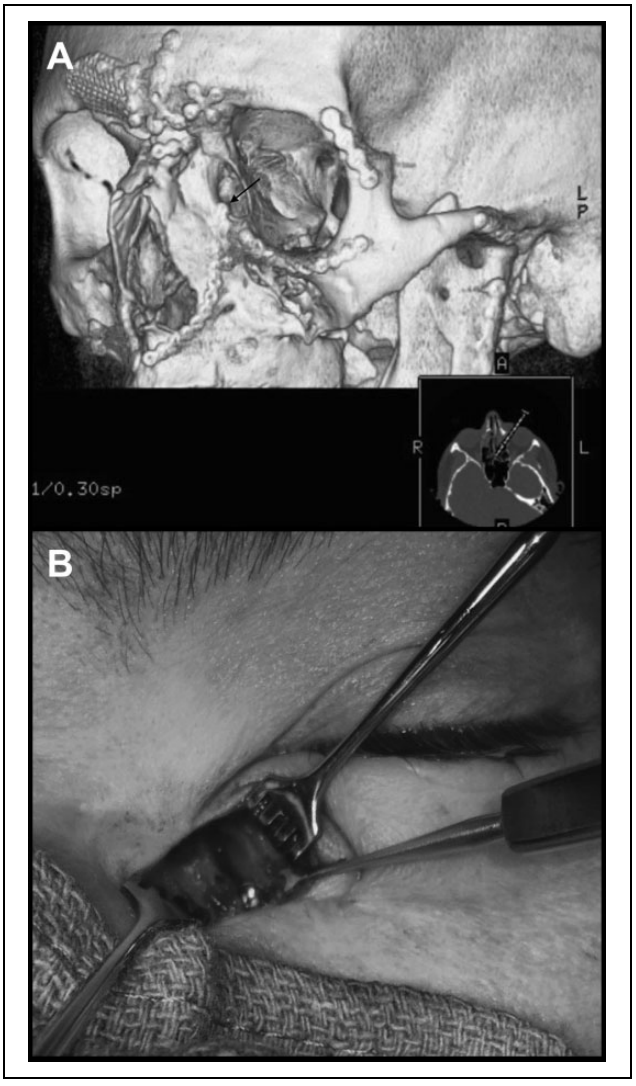

Figure 2. Case 4: Volume rendering of the CT orbit (A) shows a screw (black arrow) going through the lacrimal sac fossa. An image taking intraoperatively (B) also demonstrates the screw entering the lacrimal sac fossa. CT indicates computed tomography.

over the ostium for 5 minutes intraoperatively to prevent scar tissue formation. Five of the 6 patients (83%) had complete resolution of symptoms and patency of the nasolacrimal system on probing and irrigation at their last follow-up visit. The average follow-up period was 13.5 months (range 3-30 months).

The following 2 cases highlight hardware-related factors contributing to epiphora, as well surgical techniques used to address this complication.

Selected Case Descriptions

Case 1: An 80-year-old man was 4 months status-post excision of a left stage T4N0M1 fronto-ethmoidal squamous cell carcinoma (SCC) with extension into the left forehead and left medial orbit. Excision involved removal of the anterior two-thirds of the medial orbital wall up to the frontal process of maxilla, as well as the medial half of the lacrimal sac. Following wide local excision, the medial wall was reconstructed with a titanium-porous polyethylene implant (Medpor Titan, Stryker, Kalamazoo, Michigan) that spanned from the posterior edge of the medial wall defect to the frontal process of maxilla. The implant was fixated anteriorly to the frontal process of maxilla with microplate screws (Figure 1A and B). A bicanalicular Guibor intubation stent was placed through the upper and lower canaliculi and wrapped above the medial wall implant into the patient's nasal cavity.

The patient presented to the oculoplastic clinic with chronic left-sided epiphora and purulent ocular surface discharge. The patient was diagnosed with chronic dacryocystitis and was scheduled for a left external DCR.

During external DCR, it was noted that the medial wall implant extended along the entire anteroposterior distance of the medial wall of the orbit, overlying the osteotomy created during the prior resection. The anterior third of the implant was rongeured to expose the previous osteotomy and the

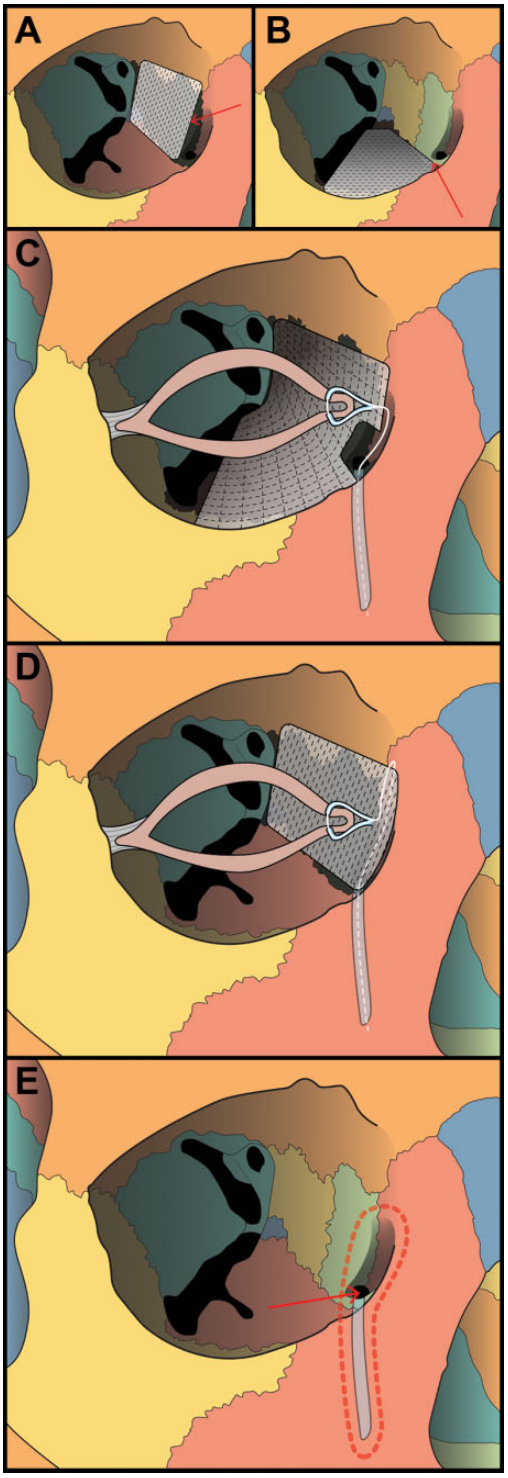

Figure 3. A, Proper placement of a medial wall implant following tumor resection. The medial wall defect is covered by an implant whose anterior edge (arrow) is at the original position of the posterior lacrimal crest. A gap remains between the anterior edge of the implant and the orbital rim. B, Proper placement of an orbital floor implant, lateral to the nasolacrimal duct canal (arrow). C, Proper placement of an orbital floor-medial wall implant following tumor resection. The implant contains an inferomedial gap through which stents can be placed. D, Incorrect placement of an orbital medial wall implant following tumor resection. No inferomedial gap is maintained and a stent is guided over the top of the implant which will not create a sufficient conduit for tear drainage as gravity will overcome capillary action. E, The red shaded zone highlights areas of the maxillary bone through which screws should not be placed as this could obstruct either the nasolacrimal sac or duct (arrow).

silicone stents were placed inferonasally through this new passage. The patient was epiphora-free 6 months postoperatively with 100% patent lacrimal system irrigation.

Case 4: A 29-year-old man presented with left-sided epiphora. The patient reported left-sided facial trauma 2 years prior that required reconstructive surgery. Operative reports from the prior surgeries were unavailable. On imaging, microplate fixation screws through a linear titanium implant appeared to enter the left lacrimal sac fossa (Figure 2A).

We performed an external DCR, during which screws were found to be placed through the frontal process of maxilla into the lacrimal sac fossa (Figure 2B). The titanium plate and screws were explanted and an external DCR was performed. The patient was epiphora-free 3 months postoperatively with 100% patent lacrimal system irrigation.

Discussion

Maxillofacial hardware was demonstrated as the primary cause of NLO in this series. This finding is supported by intraoperative observations, as well as the resolution of epiphora following hardware revision in 83% of patients. Hardware-induced NLO was the indication for DCR in 1.4% of all cases at our institution over a 5-year span. Given that only 3 cases of hardware-induced NLO have previously been published, this condition is likely infrequent but underreported.[17-19] This series highlights the need for attention to nasolacrimal anatomy during oculofacial reconstruction with the placement of orbital hardware and/or microplate fixation hardware.

Two mechanisms of hardware-induced epiphora were encountered in this series. The first mechanism (cases 1-6) was that of an orbital implant impeding communication between the inferomedial orbit and nasal cavity. In order to avoid this complication, care should be taken to place medial wall implants posterior to the posterior lacrimal crest, avoiding impingement of the lacrimal sac (Figure 3A). Similarly, orbital floor implants should be placed lateral to the lacrimal sac fossa and NLD canal (Figure 3B). When an implant spans the orbital floor and medial wall, a gap should be maintained between the anterior aspect of the implant and the frontal process of maxilla. This can be achieved by shortening the implant or by creating an effective "osteotomy" within the inferomedial aspect of the implant. Through this opening, lacrimal stents may be passed (Figure 3C). Wrapping lacrimal stents superior to a medial wall implant into the nasal cavity will not create a sufficient passage for tear drainage, as capillary action will

be overcome by the force of gravity (Figure 3D). Three of the patients in the present series had prior lacrimal drainage stenting but still developed NLO (cases 1, 2, and 6). In these cases, we found that either the medial wall implant (case 1) or the orbital floor implant (cases 2 and 6) was placed anteromedial to the border of the lacrimal sac fossa, eliminating communication between the proximal portion of lacrimal drainage system and nasal cavity. Unlike the 3 previously published case reports of hardware-induced epiphora, it is less likely obstruction occurred due to migration of the implant since all implants in this series were fixated by microscrews.[17-19] This brings us to the second mechanism of hardware-induced NLO: the placement of microplate fixation screws through maxillary bone and into the lacrimal sac or NLD (cases 3 and 4). Figure 3E highlights areas where microplate fixation screws must be placed with caution.

In patients with a history of epiphora following oculofacial reconstruction, imaging is useful to help identify the etiology and assist in operative planning. Once hardware-induced epiphora is recognized, the obstruction must be removed. The removal of obstructing hardware during the external DCR can be challenging in these cases. Orbital anatomy is often distorted from prior surgery and scar tissue, particularly with titanium implants that promote osseointegration, can be robust.[20,21] However, in order to successfully restore tear flow, it is imperative to create a direct pathway connecting the lacrimal system and nasal cavity. If left unaddressed, NLO can not only lead to epiphora but also to other sequelae including dacryocystitis, orbital cellulitis, and, in rare cases, loss of vision.[22,23] After an external DCR with concurrent implant revision, the success rate in this series was 83%.

The weaknesses of this study include its retrospective noncomparative design and, given the infrequent nature of implant-induced epiphora, a small sample size and limited in-person follow-up in 1 case (though the patient confirmed over the phone the resolution of her symptoms 24 months postoperatively). As mentioned previously, despite visualization of hardware misplacement, it is possible that epiphora was partially caused by mechanisms other than hardware placement. Cases 1, 2, 5, and 6 underwent radiation, chemotherapy, and postoperative scarring following primary tumor resection, all of which can contribute to the development of NLO.[12,24,25] These factors may explain the recurrence of epiphora in case 5 despite revision of orbital hardware, use of MMC during external DCR, and creation of an adequate passageway between the lacrimal sac fossa and nasal cavity. In a retrospective study of 37 patient who had undergone an external DCR following external beam radiation, ablative surgery and/or chemotherapy, 28% of patients had persistent epiphora.[26] Thus, in cases when tissue loss is severe or there has been scarring secondary to radiotherapy and/or surgery, ideal implant placement and an external DCR maximize the odds of success but do not guarantee the absence of epiphora.

To our knowledge, this is the first case series documenting maxillofacial hardware-related epiphora. In order to minimize the risk of epiphora, certain anatomical principles should be respected when reconstructing the orbit. First, preserve a direct inferonasal conduit between the lacrimal sac fossa and the nasal cavity during reconstructions. Second, avoid the placement of microplate fixation screws through maxillary bone near the lacrimal sac or NLD. When implant-related epiphora is diagnosed, implant revision in combination with DCR surgery is generally effective in reestablishing tear flow into the nasal cavity.

Authors' Note

This article was presented as a poster at the ASOPRS 49th Annual Fall Scientific Symposium, October 25-26, 2018, Chicago, IL.

Acknowledgment

Figure 3 created by Vincent Calabro.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was financially supported in part by unrestricted institutional grant from Research to Prevent Blindness.

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