Diplopia Following the Insertion of a Canalicular Bypass Tube: Etiology, Risk Factors, Management, and Outcomes

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Purpose: To report the etiology, management, and possible risk factors for diplopia after canalicular bypass surgery.

Methods: A multicenter retrospective, noncomparative case series of patients who developed diplopia following canalicular bypass surgery were assessed.

Results: Twenty-four cases of diplopia were identified across 12 institutions. Tubes were inserted as a primary procedure with external dacryocystorhinostomy (DCR) (1; 4%) or without DCR (10; 42%) or as a secondary procedure after external (8; 33%) or endonasal (5; 21%) DCR. Factors predisposing to local damage were noted in 17 (71%): these factors included preexisting autoimmune/inflammatory condition (7 cases), medial canthal tumor resection (5 cases), preoperative radiotherapy (2 cases), 2 drug treatments (topical and systemic), and 1 local surgery. Horizontal diplopia was due to restriction of abduction and first noted at a median of 3.5 months (mean: 17.8 months, range: 1 day to 112 months) and persisted in 23 (96%) cases with a mean restriction of −2, affecting primary gaze in 4 patients and activities of daily living in 13 (42%). Seventeen patients received various treatments: 10 were operated on resulting in cure in 1 and improvement in 9. A stable degree of diplopia persisted in all but one patient.

Conclusions: Restriction of abduction causing horizontal diplopia is a rare complication with canalicular bypass surgery and a notably high proportion occurred after tube placement without DCR; carunculectomy was not ubiquitous. Although in some the diplopia may be improved with intervention, the chance of cure is low. This complication should probably be included during informed consent for canalicular bypass tubes.

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In the presence of significant canalicular obstruction, a lacrimal bypass tube (conjunctivodacryocystorhinostomy) is indicated either as a primary procedure or as a secondary procedure after primary DCR has healed.[1,2] Primary insertion without a DCR has also been described.[3] Complications of canalicular bypass tubes include extrusion, migration, loss of tube, granuloma formation, ocular discharge, and localized episcleritis, these occasionally requiring tube repositioning or replacement—potentially with multiple procedures over a lifetime.[4–6]

Although diplopia is a recognized complication of bypass tubes and often described as a restrictive strabismus due to localized conjunctival scarring, fewer than 15 cases have been reported to date.[6–12] The authors report a series of patients with diplopia after canalicular bypass surgery, identify possible mechanisms, and report various managements and outcomes.

METHODS

A multicentre (12 institution) retrospective, noncomparative case series of patients who developed diplopia after canalicular bypass surgery were identified. Patients had placement of a bypass tube at the time of primary DCR, as a secondary procedure after DCR, or in the absence of any DCR; patients were excluded if records were inadequate or if they had diplopia prior to bypass surgery. DCR is defined as the formation of a large bony osteum, opening of the lacrimal sac with the formation of mucosal appositional flaps, and subsequent opening of the nasal mucosa with reciprocal nasal mucosal flaps to create a fistula within the bony osteum. DCR without Lester Jones tube is defined as

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the insertion of the tube without a prior large bony osteum or formation of flap, rather a 2.1-mm needle is placed through the conjunctiva and lacrimal bone at a 40° angle followed by progressive dilation to form a tract with subsequent insertion of the angled (130°) Lester Jones tube as previously described.[13] Carunculectomy when carried out specifically involved the tip of the caruncle is grasped, and the caruncle is top-sliced to excise any prominence (essentially a partial carunculectomy), taking care not to excise completely and leaving a clear margin of conjunctiva plus avoiding any disruption of the plica.[14] The limitation of eye movements was quantified between −1 and −5 ("−5" esotropia and unable to reach midline; "−4" no abduction beyond midline (100% limitation); "−3" 75% limitation beyond midline; "−2" abduction to only half of full range; and "−1" mild limitation of extreme abduction). Consent was obtained for photographs and is on file. Local ethical approval was obtained, and the study adheres to the ethical principles outlined in the declaration of Helsinki.

RESULTS

Twenty-four patients developed diplopia (Table and Fig. 1), and possible causal factors were identified in 17 (71%): local preexisting autoimmune/inflammatory condition (7 cases), prior excision of medial canthal tumor (5), local surgery (1), prior local radiotherapy (2), long-term use of a topical prostaglandin analogue (1), and long-term systemic immunosuppression (1).

The canalicular bypass tube was inserted as a primary procedure with external DCR (1 case; 4%) or without DCR (10; 42%) or as a secondary procedure after external (8; 33%) or endonasal (5; 21%) DCR. Carunculectomy was performed in 10 of 24 (42%) cases, this being complete in 2 of 10 patients (cases 9 and 10; Table). Bypass tubes were straight (14), angled (8), or Medpor-coated (Stryker, U.S.A.) (1) and had lengths of between 13 and 22 mm (mean: 17 mm; median: 18 mm). The technique of insertion varied from direct conjunctivorhinostomy without DCR (6), guidewire and trephine (3), K-wire and 14G (brown) Venflon (BD, U.S.A.) intravenous cannula (4), K-wire and gold dilator (1), scissors and probe (3), Stop-loss (FCI Ophthalmics, France) introducer (1), scissors (1), or unrecorded (5 cases; Fig. 1).

Horizontal diplopia due to restricted abduction was first noted at a median of 3.5 months (mean: 17.8 months; range: 1 day to 112 months) and persisted in all but one case. Eight reported a gradual worsening of diplopia after onset before finally stabilizing. Restriction ranged from −1 to −4 (mean restriction: −2; mode: −3) and −5 affecting primary gaze in 4 (17%) individuals (Fig. 2). Activities of daily living were affected in 13 (42%), with driving being the most significant problem.

Improvement occurred in 9 after various treatment interventions (Table) and remained stable in 15 cases. Onset of diplopia was sooner for cases involving DCR (mean: 13 months) compared with no DCR (mean: 25 months). In 5 cases, who had undergone prior tumor excision, the restriction was severe, with the scar extending from the semilunar fold toward the medial rectus and bulbar conjunctiva.

Seventeen patients (71%) had treatment, 9 of 17 (53%) having some improvement and 1 of 17 being cured. Surgery was performed in 10 of 17 cases: the main interventions being release of scar tissue (adhesiolysis in 6) and adhesiolysis with conjunctival autograft (4) or oral mucous membrane grafting (1). Local corticosteroid was used in 5 cases, 3 injections in combination with surgical intervention and 2 as topical drops alone.

Total number of conjunctivodacryocystorhinostomy cases across the 12 institutions was 2,246, and with 24 cases identified, a reasonable estimate of incidence would be about 1%.

DISCUSSION

Horizontal diplopia due to the restriction of abduction is rare after placement of canalicular bypass tubes, although it might be underestimated due to the authors' not routinely examining eye movements in these patients. In most cases, the diplopia occurred some considerable time after surgery and in many cases was slowly progressive, this suggesting a gradual scarring process. A curiously high proportion of cases appear to have occurred after placement without DCR.

Diplopia in far abduction has relatively little impact except during driving, which was the impairment of daily activity highlighted by many of the authors' patients. Four patients did, however, have diplopia in primary position and downgaze, this causing significant functional impairment. Despite many interventions to reduce the diplopia, only in 38% did it improve and it was cured in only one case (4%).

Previous surgery in the medial canthal area may be a risk factor for developing subsequent restrictive strabismus following canalicular bypass surgery, and 5 cases had local tumor excision. Preceding radiotherapy was given to 2 patients and is also a potential risk factor.[15,16] Ironically, the initial cause of the canalicular obstruction may well be a risk factor for this occurrence of diplopia (scarring posttumor reconstruction, radiotherapy, lichen planus, ocular cicatricial pemphigoid, and herpetic canaliculitis).[17,18] However, it is not possible to establish these as etiological local factors as many of these factors are among the indications for canalicular bypass surgery. It is likely that these would be equally as prevalent in patients who do not develop restrictive diplopia following canalicular bypass surgery.

Complete or partial carunculectomy, extending to the plica, may induce scar tissue formation to induce a restrictive strabismus. However, over 50% of cases did not undergo carunculectomy. Creating fibrosis by placing a lacrimal bypass tube within the vicinity of the pulley mechanism (as described by Koornneef and Zonneveld[19] and Koornneef[20]) of the medial rectus, causing chronic attrition, could explain limitation of movement, even in those cases with a previous DCR. Making a clean incision just posterior to the caruncle but medial to the plica, that is, a plical-sparing incision, may help avoid damage to this system. This may be exacerbated by the presence of proinflammatory bypass tubes such as a Medpor-coated tubes. Of course, principles of atraumatic dissection and minimal use of cautery with surgical technique may also help minimize the potential for restrictive diplopia.

Perhaps most noteworthy is the observation that 42% of cases in this series involved tube placement without a DCR. These tubes were the longest in length (minimum 17 mm, the majority being 20 or 22 mm), thus inferring more vertical placement. Despite placement within the caruncle and distant to the plica, without carunculectomy, this appears to have caused progressive inflammatory scarring of Tenon's, conjunctiva, and ultimately the intricate pulley system of the medial rectus. It is plausible that the presence of a fistulous tract between the preserved but now pierced lacrimal sac and Tenon's capsule may expose Tenon's to retained lacrimal mucosal secretions, inciting chronic fibrosis and contraction. This possible theory would be supported by the later onset of diplopia in cases that had undergone tube placement without DCR in comparison to tube placement with DCR, where perhaps an alternative mechanism may have played a role. Another possible explanation is that the lack of DCR means that there is ridged bone surrounding the bypass tube making it fixed in a possibly posterior position resulting in progressive inflammation.

All treatment methods employed were varied, ranging from local steroid drops, injection, release of adhesions and mucous membrane grafting.[8,9] Although improvement occurred, those achieving total resolution of diplopia were few. Ashenhurst et al[7] describe a stepwise approach using topical steroids first, adhesiolysis with a conjunctival patch graft if large and adhesiolysis with mitomycin C in the most scarred

Summary of 24 cases with diplopia after bypass surgery insertion

	Predisposing	Surgical factors				Diplopia						Treatment	
	PMH	P/PD/SD	Bypass	Car	Insert	Onset (months)	T/P	R	ADL	Gaze	S/Prog	Intervention	Outcome
1	66 Gy radiation for MC BCC	P	22 mm, A, LJT	N	Conjunctivorhinostomy	46	P	−4	Y	Pr	S	Recession of MR, adhesiolysis, adhesiolysis with conjunctival autograft, adhesiolysis with botox to MR, local steroid	New recurrence and autograft planned
2	Hyperthyroid	P	22 mm, A, LJT	N	Conjunctivorhinostomy	0.1	P	−3	Y	L	S	Adhesiolysis	Improved
3	44 Gy B-cell lymphoma lac sac	PDext	22 mm, A, LJT	N	Conjunctivorhinostomy	6.9	P	−3	Y	L	S	Z-plasty	Improved
4	Nil	P	22 mm, A, LJT	N	Conjunctivorhinostomy	112	P	−4	Y	L	S	Z-plasty	Improved
5	Herpetic dermatitis and ophthalmicus	P	22 mm, A, LJT	N	Conjunctivorhinostomy	0.5	T	−1	N	L	S	Topical steroids	Resolved
6	Immunosuppression for kidney transplant	P	22 mm, A, LJT	Y	Conjunctivorhinostomy	37	T/P	−3	Y	Pr	S	Prism only	Stable
7	Dacryocystectomy for sac SCC	SDext	14 mm, S, LJT flange	Y	Guidewire and trephine	66	P	−3	N	L	Prog	Removal of tube	Stable
8	Prostaglandin drops for glaucoma	SDext	14 mm, S, LJT flange	N	Guidewire and trephine	24	P	−4	Y	L	Prog	Nil	Stable
9	Excision of MC BCC	SDext	Unk mm, A	Y	Scissors	0.03	P	−2	Y	L /M	Prog	Nil	Stable
10	Herpetic canaliculitis	SDendo	14 mm, S	Y	Unk	3	P	−0.5	N	L	S	Topical steroids	Improved
11	Excision of MC SCC	SDext	16 mm, S, Medpor flange	N	Unk	1	P	−0.5	N	L	S	Nil	Stable
12	Fibrosing alopecia	SDext	13 mm, S, LJT	Y	K-wire and ventflon	2	P	−1	Y	L	S	Nil	Stable
13	Excision of MC BCC	SDendo	13 mm, A, LJT	Y	K-wire and ventflon	8	P	−2	N	L	S	Release of scar and replacement of tube. Adhesiolysis, topical steroids	Improved
14	Ocular cicatricial pemphigoid	SDendo	13 mm, S, LJT	Y	K-wire and ventflon	1	P	−3	N	L	Prog	Adhesiolysis, mucous membrane grafting. Local steroids	Stable
15	Maxillectomy for SCC	Sdext	22 mm, S	N	Scissors and probe	Unk	P	−1	N	L	S	Nil	Stable
16	Nil	P	20 mm, S	N	Scissors and probe	Unk	P	−1	N	L	S	Nil	Stable
17	Nil	P	20 mm, S	N	Scissors and probe	Unk	P	−2	N	L	S	Nil	Stable
18	VII nerve palsy and eyelid surgery	P	Unk mm, LJT	Unk	Unk	1	P	−3	Y	L /M/U/ Do	S	Removal of tube, adhesiolysis, conj autograft, MR−4 mm	Improved
19	Nil	P	17 mm, S, LJT	N	Unk	0.1	P	−3	Y	Pr, L	Prog	Botox to MR	Improved
20	Uniocular amblyopia	P	18 mm, S, LJT	N	Unk	6	P	−3	Y	Pr, L, U	Prog	Removal of tube, MR surgery	Pending
21	Lichen Planus	Sdext	Unk	Y	Guidewire and trephine	0.1	P	−1		L	Unk	Offered conjunctival V-Y plasty	Stable
22	Nil	Sdendo	18 mm, S, LJT	N	K-wire and ventflon	4	p	−2	Y	L	Prog	Removal of tube, conj autograft	Improved
23	Ankylosing spondylitis	Sdendo	17 mm, S, LJT stop-loss	Y	Stop-loss introducer	Unk	p		N	L	S	5FU injection	Stable
24	Caustic soda	Sdext	15 mm, S, LJT	Y	K-wire and gold dilator	36	p	−3	Y	L	Prog	Adhesiolysis, local mitomycin C and conj autograft	Improved

A, angled; ADL, activity of daily livings; BCC, basal cell carcinoma; Car, carunculectomy; Conj, conjunctiva; D, dacryocystorhinostomy; Do, Downgaze; Endo, endoscopic; Ext, external; Insert, insertion of bypass tube technique; L, lateral gaze; Lac, lacrimal; LJT, Lester Jones tube; M, medial gaze; MC, medial canthal; MR−, medial rectus recession; P, primary insertion without dacryocystorhinostomy surgery; Pe, permanent; PMH, past medical history; Pr, primary gaze; Prog, progressive diplopia; R, restriction defined as −4 = no movement beyond midline (100% limitation), −3 = 75% limitation beyond midline, −2 = 50% limitation beyond midline, i.e., duction only half way from midline to normal full abduction, −1 = 25% limitation only, and 0 = no limitation, i.e., full abduction; S, static diplopia; S, secondary insertion after dacryocystorhinostomy surgery; S, straight; St, Static; T, temporary, U, upgaze; unk, unknown V-, V shape to Y shape; 5FU, Fluorouracil; SCC, squamous cell carcinoma.

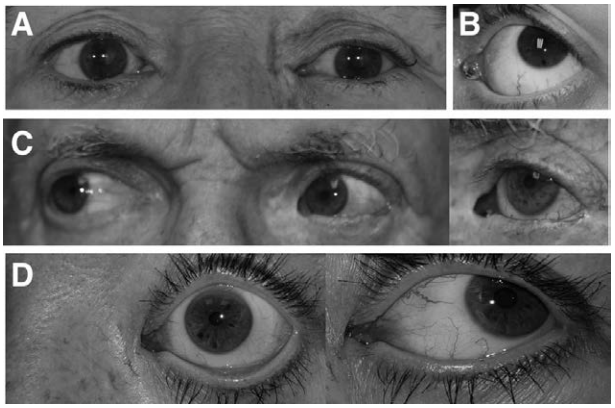

FIG. 1. Representative images of diplopia after lacrimal bypass surgery. **A**, Patient 1 who underwent radiation treatment for a left medial canthal basal cell carcinoma and resultant restriction of −3. **B**, Patient 10 with herpetic canaliculitis with diplopia on extreme left gaze only; −1 restriction. **C**, Patient 11 who underwent excision of a left medical canthal SCC excision with −1 restriction in right gaze. **D**, Patient 21 who has a local preexisting autoimmune condition, lichen planus, resulting in −1 restriction in lateral gaze. SCC, squamous cell carcinoma.

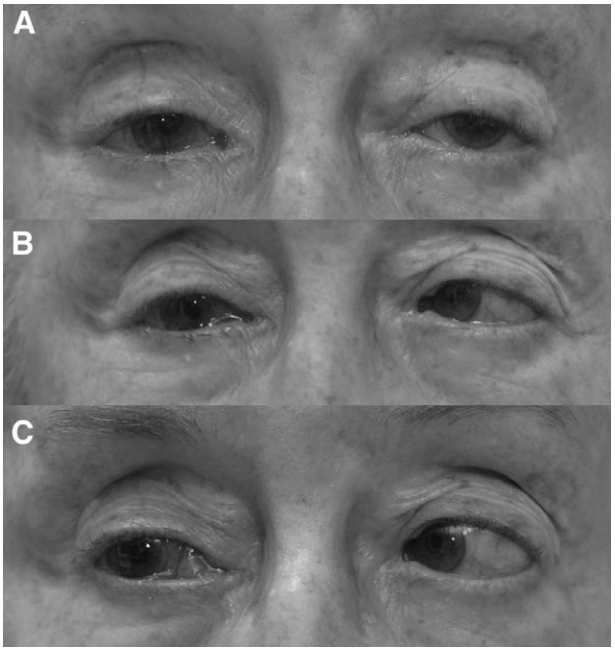

FIG. 2. Patient 14. **A**, Primary position with subsequently diagnosed, right ocular cicatricial pemphigoid. **B**, In right gaze with significant restriction −3. **C**, After adhesiolysis and buccal mucous membrane grafting.

cases. The 3 that progressed in the authors' series were 2 who had undergone prior tumor excisions and 1 patient on a topical prostaglandin analogue (for glaucoma). Successful treatment has been described with removal of the proinflammatory tube, adhesiolysis, injection of triamcinolone, and a conjunctival rotation flap to reduce residual shortening.[8] While mucous membrane grafting helps provide more medial canthal bulbar mucosa, it does not restore a motile inner canthus, in the same principle that a fornix graft fails to give a motile fornix. Grafting (conjunctival or oral mucous membrane autograft) can release a tight contracture but in itself does not appear to afford improved motility.[21,22]

CONCLUSION

This study reports a large case series of patients with restriction of abduction and horizontal diplopia following canalicular bypass surgery. The largest proportion appear to have occurred following a primary procedure without prior or concurrent DCR. Carunculectomy was not ubiquitous. In many cases, the diplopia can be improved with intervention, but the chance of cure is low, and so the risk for this complication should be included in informed consent for canalicular bypass tubes.

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