Title
Identification and Correction of Restrictive Strabismus After Pterygium Excision Surgery

Authors
Baxter, Sally L
Nguyen, Brian J
Kinori, Michael
et al.

Publication Date
2019-06-01

DOI
10.1016/j.ajo.2019.02.004

Peer reviewed

Published in final edited form as:
Am J Ophthalmol. 2019 June ; 202: 6–14. doi:10.1016/j.ajo.2019.02.004.

Identification and correction of restrictive strabismus following pterygium excision surgery

Sally L. Baxter[1], **Brian J. Nguyen**[1], **Michael Kinori**[1,2], **Don O. Kikkawa**[1,3], **Shira L. Robbins**[1], and **David B. Granet**[1]

[1]Shiley Eye Institute and Viterbi Family Department of Ophthalmology, University of California San Diego, La Jolla, CA, USA

[2]Department of Ophthalmology, The Goldschleger Eye Institute, Sheba Medical Center, Tel Aviv University, Tel Aviv, Israel

[3]Division of Plastic Surgery, University of California San Diego, La Jolla, CA, USA

Abstract

Purpose: To report the characteristics of patients with restrictive diplopia following pterygium excision and a successful treatment approach for the strabismus.

Design: Retrospective interventional case series.

- Setting: Single academic institution.
- Patient Population: Fifteen patients with restrictive diplopia after pterygium excision. Exclusion criteria: any other reason for strabismus.
- Observation Procedures: Patients were evaluated for deficits with special attention to diplopic measures. The intervention was a combined procedure by a strabismologist and oculoplastic surgeon to correct the diplopia.
- Main Outcome Measures: Subjective and objective improvement of diplopia.

Results: Fifteen patients (mean age 49 years) who developed diplopia after pterygium excision were included. Mean time to diplopia was 6 months. All patients had limited abduction in the previously operated eye, causing esotropia in the abductive field (mean deviation 18 prism diopters). After intervention, all patients were no longer diplopic in primary gaze. In the abductive field, eleven (73%) patients had residual small angle esotropia (mean 7 prism diopters) in ipsilateral extreme end-gaze only. Only two patients required additional surgical intervention for scar tissue removal. No patients underwent medial rectus recession.

Corresponding Author: David Granet, MD, FACS, FAAO, FAAP, Anne F. Ratner Professor of Ophthalmology & Pediatrics, Shiley Eye Institute and Viterbi Family Department of Ophthalmology, University of California San Diego, 9415 Campus Point Drive, La Jolla, CA 92093, Phone: (858) 534-7440, Fax: (858) 534-5695, dgranet@ucsd.edu.

Conclusions: Restrictive diplopia is a potential complication after pterygium excision, particularly for patients with a history of recurrent pterygia requiring multiple excisions and prior amniotic membrane graft placement with fibrin glue. However, diplopia after pterygium excision in primary position is surgically correctable with scar tissue removal and ocular surface reconstruction, without needing medial rectus recession. Given the high volume of pterygium excision, awareness of post-operative restrictive strabismus and the potential for correction is critical.

Introduction

Pterygium is a superficial benign fibrovascular proliferation extending from the conjunctiva onto the cornea. Pterygium excision is generally effective in removing the growth and reducing associated symptoms such as ocular surface irritation and induced astigmatism. The risks of surgery, final cosmetic result and rates of recurrence are well-known, are widely discussed in the literature, and have led to the development of numerous surgical techniques. Due to rates of recurrence reported as high as 80% for the bare sclera technique,[1] adjunctive techniques such as conjunctival autografts (CAG) and amniotic membrane graft (AMG) placement with or without fibrin glue have become more widely employed, with reduced recurrence rates ranging from 2 to 40%.[1–4]

Restrictive strabismus and diplopia are uncommon following pterygium surgery and little is known about this complication, with only a few case reports in the literature.[2–7] Furthermore, no published reports have included cases of strabismus following pterygium excision with AMG placement, although it has become much more frequently employed as an adjunctive surgical technique with pterygium excision in recent years. In addition to AMG placement, several other adjunctive interventions have also been employed during pterygium excision, such as the use of fibrin glue, antineoplastic agents mitomycin C (MMC) and 5-fluorouracil (5-FU), as well as symblepharon rings. How these adjunctive interventions affect the risk of restrictive strabismus post-operatively is not well known.

The purpose of this study was to report the clinical characteristics of patients with restrictive strabismus and diplopia following pterygium excision surgery, as well as the treatment modalities undertaken to resolve the strabismus.

Methods

This was a retrospective case series performed at a single academic medical center. Retrospective chart review was performed on all patients between July 1, 2007 and January 1, 2018 seen at the University of California San Diego (UCSD) Shiley Eye Institute and Viterbi Family Department of Ophthalmology with a complaint of diplopia after having prior pterygium surgery, whether at UCSD or at another institution. UCSD Institutional Review Board (IRB) Committee approval was obtained before the study began and granted waiver of documented consent. The study was conducted in compliance with the United States Health Insurance Portability and Accountability Act (HIPAA) and adhered to the tenets of the Declaration of Helsinki.

The inclusion criteria for the study were complaints of diplopia on presentation and history of one or more pterygium excision procedures prior to presentation of diplopia. Patients were excluded from the study if they had any other reason for strabismus or diplopia, such as prior history of strabismus, thyroid eye disease, myasthenia gravis, history of scleral buckle, or history of cranial nerve palsy. Fifteen patients were identified who met these eligibility criteria.

All subjects underwent a comprehensive ophthalmological examination, including visual acuity, stereopsis testing, measurement of extraocular motility with assessment of ductions, measurement of ocular alignment using prism cover testing, slit lamp examination with specific attention directed to conjunctival scarring and symblepharon formation, and examination for any other pathological processes.

Surgery to remove scar tissue formation and improve the diplopia was performed utilizing a team approach, including a strabismologist and an oculoplastic surgeon or a corneal specialist. Forced duction testing was performed intraoperatively. A nasal limbal incision was performed in all cases. Fibrous scar tissue was dissected posteriorly in order to relieve the restriction. Muscle hooks were then used to isolate and identify the medial rectus muscle to help strip the medial rectus muscle of adhesions and prevent it from being damaged during dissection. With the medial rectus muscle residing safely on the hook and secured, scar tissue was identified and pseudotendons were excised. The extent of dissection was based on the amount needed to free the forced ductions to abduction and symblepharon. The medial rectus was not recessed. In one patient, botulinum toxin was injected to the medial rectus intra-operatively. The residual exposed scleral bed was measured with calipers, and ocular surface reconstruction was performed with either a CAG or AMG or both. Forced duction testing was then repeated after all scar tissue was released and reconstruction completed to demonstrate that the restriction had been fully released. All patients received injection of dexamethasone around the surgery site as well as Provisc (Kabi Pharmacia Ophthalmics, Monrovia, California) around the medial rectus muscle, with the rationale that a non-antigenic, non-inflammatory viscoelastic substance may help prevent subsequent scar formation and restriction, similar to how viscoelastic substances are used in strabismus surgery involving adjustable sutures and in many medical scenarios to decrease fibrosis. In twelve patients with severe forniceal shortening, a Symblepharon Ring was placed (FCI Ophthalmics, Pembroke, Massachusetts) which remained on the eye for a period of 2–8 weeks. Eleven patients also received MMC intra-operatively or 5-FU injections intra-operatively. Eight patients received post-operative injections of 5-FU. In all patients, frequent use of steroid drops was recommended along with a Medrol dose pack. Summary statistics for all subject data were analyzed using Excel (Microsoft, Redmond, Washington).

Results

Fifteen patients were identified with restrictive strabismus following prior pterygium surgery (Table 1). The cohort was equally divided between women (8, 53%) and men (7, 47%). The mean age at presentation was 49 years (range 23–68 years). All patients had previously undergone at least one surgery for excision of a nasally located pterygium. One-third of the patients had prior bilateral pterygium excision, while two-thirds of the patients had undergone multiple prior pterygium-related operations in any given eye (e.g. for recurrent pterygia). The median number of prior pterygium-related surgeries per patient was 2, and the median number of prior pterygium-related surgeries per eye was 1.5. Seven (47%) patients had prior AMG placement at the time of pterygium excision, all affixed with fibrin glue. Two (13%) had CAG placement with sutures at the time of pterygium excision. The graft type for the remaining six patients was unknown, as they had undergone pterygium excision at an outside institution prior to presentation, and no operative records were available.

The mean time for onset of diplopia after the last pterygium surgery was 6 months (range 1–20 months). All patients had moderate limitation of abduction in the previously operated eye, as well as diplopia and esotropia in the abductive field of gaze, with an average deviation of 18 prism diopters (range 10–35 prism diopters, Table 2). In primary gaze, six (40%) patients had an esotropia (ranging from 10–30 prism diopters), and two (13%) had an intermittent esotropia, while the remaining were either esophoric or orthotropic. One patient (patient 6) had limitation of motility in all directions in the affected right eye (−1 abduction, −2 adduction, −1 infraduction, and −1.5 supraduction). Not only did he have esotropia on right gaze, but he also had exotropia on left gaze. Intra-operative exploration in this patient revealed exuberant scar formation surrounding multiple muscles, consistent with the pre-operative exam findings.

Eight (53%) patients also had a vertical deviation in addition to the horizontal deviation, although in all cases the vertical deviation was much smaller in magnitude than the horizontal deviation. Three (20%) patients had a small angle (2–3 prism diopters) vertical deviation of the involved eye in primary gaze, with two being hypotropic and one being hypertropic. Six (40%) patients had a manifest vertical deviation in the abductive field of gaze, with an average deviation of 4 prism diopters. Two-thirds of these patients were hypotropic in abduction, and the remainder were hypertropic in abduction (Table 2).

One patient declined surgical intervention and instead underwent botulinum toxin injection to the medial rectus bilaterally, which resolved the diplopia. All remaining patients required surgical correction. These patients were found to have positive restriction in abduction in the eye with prior nasal pterygium excision during intra-operative forced ductions testing. Symblepharon formation was present during intra-operative exploration in 13 (87%) eyes. Extensive dissection of scar tissue was performed until forced ductions revealed resolution of restriction. No medial recti were found to have been disinserted. There were no abnormalities in anatomic position of all extraocular muscles except in one case with particularly exuberant scarring, in which the superior oblique was noted to have been displaced anteriorly without evidence of prior eye muscle surgery. For that particular case, the superior oblique was replaced back into its original position. One patient underwent a lateral rectus resection in the affected eye to help address the esotropia. No patient underwent medial rectus recession.

For patients who underwent surgical intervention, all patients underwent ocular surface reconstruction after surgical removal of scar tissue. The defect varied in size from 25 to 50 percent of the bulbar surface. For reconstruction, a combination of AMG and CAG were used on ten (67%) patients and secured with sutures, CAG alone was used on one patient, and AMG alone was used on three (20%) patients. One patient required a buccal mucosal graft in addition to CAG and AMG for forniceal reconstruction. After reconstruction, forced ductions testing was repeated again to demonstrate that the restriction had been fully released. Mitomycin C was administered intra-operatively in two (13%) patients, while 5-fluorouracil (5-FU) was injected either intra-operatively or on follow-up in ten (67%) patients (range 1–6 injections). A symblepharon ring was placed at the time of surgery in 12 (80%) patients with severe forniceal shortening and presence of symblepharon formation and remained in place for an average of 3.8 weeks post-operatively (range 2–8 weeks).

The average postoperative follow-up time was 24 months (range: 2 weeks-96 months). All patients noted subjective improvement in diplopia after surgical removal of scar tissue and ocular surface reconstruction. Post-operatively, no patients endorsed diplopia in primary position, and all patients endorsed either resolution or substantial improvement in diplopia in the abductive field of gaze of the affected eye. A representative montage of a patient who underwent surgical correction is depicted in Figure 1. Eleven (73%) patients endorsed persistent subjective diplopia only at the extreme end of the abductive field of gaze. On objective examination, ten (67%) patients were noted to have a small deficit noted on versions post-operatively (Table 2). None of the patients demonstrated new onset limitation in adduction after scar tissue removal and ocular surface reconstruction. With alternate prism cover testing in the abductive field, five patients (33%) had residual small angle esotropia (average 7 prism diopters, range 2–10), while seven (47%) had only intermittent esotropia (average 9 prism diopters, range 2 to 16). During the follow-up period, only two patients required additional surgical intervention for scar tissue removal. Both of these patients were orthotropic in primary gaze after the initial correction, but experienced residual esotropia in the abductive field requiring further dissection and ocular surface reconstruction. One of these patients had recurrence of scar tissue and fibrosis in the nasal conjunctiva 7 months after the initial correction. The other patient underwent scar tissue dissection and ocular surface reconstruction in both eyes initially but needed additional operative intervention in the left eye 4.5 years later due to recurrent restriction. Of note, both patients had undergone multiple pterygium excision surgeries in the eye needing re-operation (2 and 5, respectively).

Discussion

In this study, we describe a cohort of fifteen patients who had undergone pterygium excision and subsequently developed restrictive strabismus secondary to ocular surface scarring. All patients had an esotropia after excision of nasal pterygium causing diplopia in the abductive field, with mean onset about 6 months after excision.

Two patterns of misalignment following pterygium excision have been described. The first is a relatively rapid onset exotropia secondary to trauma to the medial rectus muscle during the pterygium excision with ensuing disinsertion.[2,4] The other is a more delayed onset restrictive esotropia resulting from scar tissue formation of the muscle, surrounding conjunctiva, and connective tissue. It results in restricted motility and limited abduction, diplopia particularly in the abductive field of gaze, and symblepharon formation and cicatricial damage to the fornix.[3,5,6] Whether adjunctive techniques such as CAG or AMG at the time of pterygium excision influences the incidence and/or severity of scarring and subsequent strabismus is currently unknown.

Over half of the patients in this series had undergone multiple prior pterygium-related operations in the affected eye prior to presentation, suggesting that recurrence of pterygia may be a risk factor for developing restrictive strabismus post-operatively. The development of restrictive strabismus could be related to the connective tissue trauma and/or inflammation incited by multiple operations. Furthermore, some authors have proposed that these patients may have an underlying predisposition to inflammatory cytokines that caused them to develop the recurrent pterygia in the first place.[8] This was supported by our finding that the two patients who returned to the operating room for further surgical repair of their diplopia both had a history of multiple prior pterygium recurrences.

Over half of the patients also had prior AMG placement at the time of pterygium excision. AMG is now a common adjunctive technique used during pterygium excision, yet no prior reports have included patients who had received AMGs and went on to develop restrictive strabismus. On surgical evaluation, several of the patients had massive scarring involving more than one muscle and symblepharon formation. AMG is the innermost layer of the placenta and is thought to dampen the inflammatory response, so its association with increased scarring may seem counterintuitive. However, one hypothesis is that fibrin glue, which is commonly used to affix the AMG to the surgical bed, may incite additional inflammation, causing a cicatricial response as opposed to the membrane itself. This hypothesis was explored by Zloto *et al.*[9] when comparing Vicryl sutures (Ethicon, NJ) with Tisseel fibrin glue (Baxter Corp, Deerfield, IL) and Evicel fibrin glue (Omrix Biopharmaceuticals Ltd, Ramat-Gan, Israel). Tisseel fibrin glue was comparable with Vicryl sutures in terms of pterygium excision postoperative outcomes such as recurrence. However, Tisseel fibrin glue performed better than Evicel fibrin glue, thereby suggesting possible outcome variability within the type of fibrin glue application.[9] Our patients had previous pterygium surgeries, with some of them undergoing multiple pterygium excisions, and this may have led to fibrin glue diffusion into the sub-Tenon's space and the rectus muscles, perhaps triggering a different and more exuberant fibrotic response.

During the surgical treatment of diplopia in our series, AMG was used (either alone or in combination with CAG) for nearly all of the patients, but grafts were secured with sutures as opposed to glue. Despite an average follow-up time of 24 months (quadruple the length of time to the initial onset of diplopia after pterygium excision), only two patients required another surgical intervention. This suggests that securing AMG with sutures rather than glue may potentially be less inflammatory. However, a direct comparison between sutures and fibrin glue was not possible from this retrospective study because other adjunctive measures were also used with potential anti-inflammatory effects (e.g. MMC, 5-FU, steroids). To isolate the effect of AMG affixation with sutures versus glue, prospective studies using standardized treatment protocols would be needed. This represents a potential area for future investigation.

Interestingly, in addition to esotropia, over half of the patients in this cohort had a vertical deviation in the abductive field of gaze, which has not been previously reported. This may reflect the degree of the scarring, with extension in the vertical orientation. This was confirmed by intra-operative exploration and dissection in several cases where bands of fibrosis were noted over the vertical recti. Similarly, symblepharon formation in the inferior fornix was present in over 80% of this cohort, which may have also contributed to vertical misalignment. One possible explanation for the tendency for the inferior fornix to be affected may be a gravitational component of downward settling of fibrin glue over time.

Patients in our series needed both exploration and dissection of scar tissue from the surface of the extraocular muscles in addition to ocular surface reconstruction. Release of the scar tissue and ocular surface reconstruction alone was sufficient to substantially improve the strabismus for these patients. Over half (8/15, 53%) of the patients endorsed diplopia in primary position pre-operatively. Post-operatively, none of the patients had diplopia in primary position. On presentation, all patients had diplopia in the abductive field of gaze, and post-operatively, they endorsed either resolution (4/15, 27%) or substantial improvement of this diplopia (11/15, 73%), although they did have some persistent residual diplopia on extreme end-gaze. These improvements were achieved without medial rectus recession. This implies that the mechanism for the strabismus is the scarring in the surrounding conjunctival/connective tissue, not contracture within the extraocular muscles themselves. To illustrate, the patient who underwent botulinum toxin injections to the bilateral medial rectus muscles had an esotropia of 25 prism diopters in right gaze and 30–35 prism diopters in left gaze, which improved to an intermittent esotropia of 14 prism diopters in right gaze and 16 prism diopters in left gaze after the procedure. While this improvement was satisfactory to the patient, it was not as complete an improvement as observed in the patients who underwent surgery to definitively remove all of the scar tissue surrounding the muscles. These patients post-operatively had much smaller deviations – all were less than 10 prism diopters and most were in the range of 2–4 prism diopters.

Although all patients noted subjective improvement in diplopia, the majority (11/15, 73%) did endorse persistent residual diplopia in abduction on extreme end-gaze after surgery. In general, this residual diplopia did not impact their daily activities, and they were happy with the post-operative results. Even for the two patients who went on to have further surgical intervention, they had experienced improvement and a period of recovery after the initial repair and only underwent further surgery after a recurrence of restriction (at 7 months for one patient and 4.5 years for the other). This finding is important for counseling patients pre-operatively. Patients should be informed that even with substantial reduction in diplopia, full resolution may not occur and that some residual diplopia (especially in extreme end-gaze) is likely even after surgical repair. In addition, they should be informed that recurrence of significant restriction requiring further surgery, although unlikely, is possible. Patients with multiple prior pterygium excisions, more severe restrictive strabismus on presentation, or exuberant scarring noted during the initial repair may be at higher risk of persistent diplopia and/or recurrence. Long-term monitoring of these patients may be warranted as a result.

Ocular surface reconstruction was performed using CAG, AMG, or a combination of the two based on surgeon preference, but there was no discernible difference in ultimate outcome related to type of graft that was used. The successful use of CAG and AMG in the treatment of restrictive strabismus after pterygium excision has been supported by other studies. Lee *et* *al.*[10] successfully used a conjunctival mini-flap operation, essentially an adjacent CAG, to repair a series of patients with restrictive strabismus, including two with history of pterygium excision. Strube *et al.*[11] used AMG to prevent recurrence of conjunctival scarring in a series of patients including one patient with history of pterygium excision, and similarly Solomon *et al.*[8] used AMG for forniceal reconstruction after treatment of symblepharon in two eyes after pterygium excision. In addition, Laria *et al.*[7] used AMG as well as subconjunctival and topical corticosteroids to prevent recurrence of diplopic restrictive strabismus in a series of patients with conjunctival lesions including recurrent pterygium surgery.

Antineoplastic agents, including intra-operative Mitomycin C (MMC) and intra-operative and/or post-operative 5-Fluorouracil (5-FU) injections, were utilized to reduce scar formation in the follow-up period. Use of antineoplastic agents was determined based on surgeon preference and were typically given for patients with greater magnitude of esotropia and/or motility deficits on presentation, or if exuberant scar formation was noted during intra-operative exploration. Use of MMC, an intercalating agent, has been established to reduce pterygium recurrence rates after excision.[12] MMC has further been reported to reduce post-operative adhesions and fibrosis after strabismus surgery.[13] Similarly, 5-FU, the pyrimidine antimetabolite used in this case series, has been reported as an effective chemo-adjuvant in reducing pterygium recurrence after excision in vivo[14] and in preventing post-operative adhesions and fibrosis after strabismus surgery in rabbit models.[15,16] However, antineoplastic agents also carry risk of potential adverse effects. MMC has been reported to be associated with corneal epithelial toxicity, limbal stem cell deficiency, corneal perforation, cataract, secondary glaucoma, and scleral thinning, ectasia, and necrosis.[17–23] The effects on the sclera are particularly concerning since they may complicate subsequent revision surgery. 5-FU, which is commonly used for glaucoma filtering surgeries, has been associated with corneal epitheliopathy and ulceration and more rarely with choroidal detachment, retinal detachment, hypotony maculopathy, and cataract.[24–29] These potential adverse effects must also be taken into consideration when deciding whether to use these agents.

Limitations to this study include its retrospective nature and small sample size. However, this may be related to the very low incidence of strabismus after pterygium excision,[30] which makes it difficult to generate a large sample and would limit the ability to conduct a well-powered prospective study. In addition, while this group of patients underwent the same general approach to treatment, a strict standardized protocol was not used, allowing flexibility for the treating physician to exercise his or her clinical judgment. Although variability in the surgical protocols may have decreased the standardization of results, it allowed more customization to real clinical practice. While the exact adjunctive interventions (e.g. use of symblepharon rings and/or antineoplastic agents) may have varied slightly between the patients in this series, all experienced substantial improvement in diplopia without medial rectus recession. Another limitation is the subjective recall of previous surgery in patients without records from outside our institution. This may have affected the estimation of time to developing diplopia and some possible missing data regarding prior surgery. Four patients followed up primarily with the oculoplastics service, and their post-operative results were based on subjective report of improved diplopia and on versions rather than alternate prism cover testing, which limited our ability to precisely quantify the change in magnitude of esotropia for these patients. Diplopia fields may have also enhanced the ability to quantify patients' diplopia. These were limitations of a retrospective case series compared to a prospective study with standardized follow-up protocols. Additionally, one of the patients had only 2 weeks of follow-up time. Even at that early timepoint, she endorsed full resolution of diplopia even in abductive gaze, but it would be difficult to ascertain what her long-term outcome would have been without additional follow-up. However, most of the patients had substantial follow-up periods, with almost half (7/15, 47%) followed for over 1 year, and one-third (5/15, 33%) followed for over 3 years post-operatively.

In summary, diplopia secondary to restrictive strabismus is a potential complication after pterygium excision, particularly for patients with a history of recurrent pterygium requiring multiple excisions and prior AMG placement with fibrin glue. Given the frequency of pterygium excision procedures, and increasing placement of AMG with glue, awareness of post-operative restrictive strabismus and correction potential is critical. Scarring in the conjunctiva and adjacent connective tissue can be extensive and lead to horizontal and vertical deviations, but extensive scar tissue removal and ocular surface reconstruction can resolve the restriction without necessitating intervention on the extraocular muscles themselves. However, patients should be made aware that residual diplopia in extreme gaze is possible even after a successful procedure. Possible prevention of this form of strabismus may include alternatives to graft adhesives especially in patients who have a history of aggressive scarring, and/or limitation of the original dissection when fibrin glue is involved; however, confirmatory studies would be needed to discern this further.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

a. Funding/Support: This work was supported by a National Institutes of Health (NIH)/National Library of Medicine (NLM) training grant (Bethesda, MD, grant number T15LM011271, SLB), the Heed Ophthalmic Foundation (San Francisco, CA, SLB) and supported in part by an unrestricted departmental grant from Research to Prevent Blindness (New York, NY, all authors) and an NIH core grant (Bethesda, MD, grant number P30EY022589, all authors).

b. Financial Disclosures: SLB is supported by NIH training grant T15LM011271 and the Heed Ophthalmic Foundation. SLR is a consultant for the United States Department of Health and Human Services, Prometric, and Nevakar. She receives royalties from Elsevier, Spring, and the American Academy of Pediatrics and receives grant support from Retrophin.

c. Other Acknowledgments: Chantal Boisvert, OD, MD (University of California Irvine, Irvine, CA) and Anya Trumler-Sebring, MD (Miramar Lynn Medical Group, Thousand Oaks, CA) were involved in the initial data collection while they were pediatric ophthalmology fellows at UCSD.

References

1. Hirst LW. The treatment of pterygium. Surv Ophthalmol 2003;48(2):145–180. [PubMed: 12686302]
2. Raab EL, Metz HS, Ellis FD. Medial rectus injury after pterygium excision. Arch Ophthalmol Chic Ill 1960 1989;107(10):1428.

3. Vrabec MP, Weisenthal RW, Elsing SH. Subconjunctival fibrosis after conjunctival autograft. Cornea 1993;12(2):181–183. [PubMed: 8500328]
4. Ugrin MC, Molinari A. Disinsertion of the medial rectus following pterygium surgery: signs and management. Strabismus 1999;7(3):147–152. [PubMed: 10520240]
5. Jenkins PF, Stavis MI, Jenkins DE. Esotropia following pterygium surgery. Binocul Vis Strabismus Q 2002;17(3):227–228. [PubMed: 12171596]
6. Ela-Dalman N, Velez FG, Rosenbaum AL. Incomitant esotropia following pterygium excision surgery. Arch Ophthalmol Chic Ill 1960 2007;125(3):369–373. doi:10.1001/archopht.125.3.369
7. Laria C, Shokida F, Tatarchuck P, Pinero DP, Gonzalez X. New diplopic restrictive strabismus as a sequela after conjunctival surgery for conjunctival lesions: a series of 3 cases, management and outcome. Binocul Vis Strabol Q Simms-Romanos 2012;27(2):113–121.
8. Solomon A, Espana EM, Tseng SCG. Amniotic membrane transplantation for reconstruction of the conjunctival fornices. Ophthalmology 2003;110(1):93–100. [PubMed: 12511352]
9. Zloto O, Greenbaum E, Fabian ID, Ben Simon GJ. Evicel versus Tisseel versus Sutures for Attaching Conjunctival Autograft in Pterygium Surgery: A Prospective Comparative Clinical Study. Ophthalmology 2017;124(1):61–65. doi:10.1016/j.ophtha.2016.09.010 [PubMed: 27817915]
10. Lee KH, Rhiu S, Yoon SC, Seo KY. Conjunctival mini-flap operation for restrictive strabismus after periocular surgery. Am J Ophthalmol 2013;156(6):1244–1251.e2. doi:10.1016/j.ajo.2013.06.038 [PubMed: 23972894]
11. Strube YNJ, Conte F, Faria C, Yiu S, Wright KW. Amniotic membrane transplantation for restrictive strabismus. Ophthalmology 2011;118(6):1175–1179. doi:10.1016/j.ophtha.2010.10.034 [PubMed: 21292325]
12. Chen PP, Ariyasu RG, Kaza V, LaBree LD, McDonnell PJ. A randomized trial comparing mitomycin C and conjunctival autograft after excision of primary pterygium. Am J Ophthalmol 1995;120(2):151–160. [PubMed: 7639298]
13. Kersey JP, Vivian AJ. Mitomycin and amniotic membrane: a new method of reducing adhesions and fibrosis in strabismus surgery. Strabismus 2008;16(3):116–118. doi:10.1080/09273970802405493 [PubMed: 18788060]
14. Prabhasawat P, Tesavibul N, Leelapatranura K, Phonjan T. Efficacy of subconjunctival 5-fluorouracil and triamcinolone injection in impending recurrent pterygium. Ophthalmology 2006;113(7):1102–1109. doi:10.1016/j.ophtha.2006.02.026 [PubMed: 16730066]
15. Mora JS, Sprunger DT, Helveston EM, Evan AP. Intraoperative sponge 5-fluorouracil to reduce postoperative scarring in strabismus surgery. J AAPOS Off Publ Am Assoc Pediatr Ophthalmol Strabismus 1997;1(2):92–97.
16. Eşme A, Yildirim C, Tatlipinar S, Düzcan E, Yaylali V, Ozden S. Effects of intraoperative sponge mitomycin C and 5-fluorouracil on scar formation following strabismus surgery in rabbits. Strabismus 2004;12(3):141–148. doi:10.1080/09273970490489630 [PubMed: 15370521]
17. Abraham LM, Selva D, Casson R, Leibovitch I. Mitomycin: clinical applications in ophthalmic practice. Drugs 2006;66(3):321–340. doi:10.2165/00003495-200666030-00005 [PubMed: 16526821]
18. Manche EE, Afshari MA, Singh K. Delayed corneal epitheliopathy after antimetabolite-augmented trabeculectomy. J Glaucoma 1998;7(4):237–239. [PubMed: 9713780]
19. Helal M, Messiha N, Amayem A, el-Maghraby A, Elsherif Z, Dabees M. Intraoperative mitomycin-C versus postoperative topical mitomycin-C drops for the treatment of pterygium. Ophthalmic Surg Lasers 1996;27(8):674–678. [PubMed: 8858633]
20. Lam DS, Wong AK, Fan DS, Chew S, Kwok PS, Tso MO. Intraoperative mitomycin C to prevent recurrence of pterygium after excision: a 30-month follow-up study. Ophthalmology 1998;105(5):901–904; discussion 904–905. doi:10.1016/S0161-6420(98)95034-5 [PubMed: 9593395]
21. Dougherty PJ, Hardten DR, Lindstrom RL. Corneoscleral melt after pterygium surgery using a single intraoperative application of mitomycin-C. Cornea 1996;15(5):537–540. [PubMed: 8862932]
22. Fujitani A, Hayasaka S, Shibuya Y, Noda S. Corneoscleral ulceration and corneal perforation after pterygium excision and topical mitomycin C therapy. Ophthalmol J Int Ophtalmol Int J Ophthalmol Z Augenheilkd 1993;207(3):162–164. doi:10.1159/000310424

23. Rubinfeld RS, Pfister RR, Stein RM, et al. Serious complications of topical mitomycin-C after pterygium surgery. Ophthalmology 1992;99(11):1647–1654. [PubMed: 1454338]

24. Fluorouracil Filtering Surgery Study one-year follow-up. The Fluorouracil Filtering Surgery Study Group. Am J Ophthalmol 1989;108(6):625–635. [PubMed: 2688428]

25. Patitsas CJ, Rockwood EJ, Meisler DM, Lowder CY. Glaucoma filtering surgery with postoperative 5-fluorouracil in patients with intraocular inflammatory disease. Ophthalmology 1992;99(4):594–599. [PubMed: 1302458]

26. Rockwood EJ, Parrish RK, Heuer DK, et al. Glaucoma filtering surgery with 5-fluorouracil. Ophthalmology 1987;94(9):1071–1078. [PubMed: 3684224]

27. Heuer DK, Parrish RK, Gressel MG, et al. 5-Fluorouracil and glaucoma filtering surgery. III. Intermediate follow-up of a pilot study. Ophthalmology 1986;93(12):1537–1546. [PubMed: 2433656]

28. Gressel MG, Parrish RK, Folberg R. 5-fluorouracil and glaucoma filtering surgery: I. An animal model. Ophthalmology 1984;91(4):378–383. [PubMed: 6717922]

29. Hickey-Dwyer M, Wishart PK. Serious corneal complication of 5-fluorouracil. Br J Ophthalmol 1993;77(4):250–251. [PubMed: 8494864]

30. Hirst LW. Recurrence and Complications after 1000 Surgeries Using Pterygium Extended Removal Followed by Extended Conjunctival Transplant. Ophthalmology 2012;119(11):2205–2210. doi: 10.1016/j.ophtha.2012.06.021 [PubMed: 22892149]

Figure 1. An illustrative example of a patient with diplopia after prior pterygium excision who subsequently underwent operative correction.

Pre-operative (left) and post-operative (right) images of case 2 in (top to bottom): primary gaze, up gaze, left gaze, down gaze, and right gaze. The restriction caused by the scar tissue was much improved after surgical intervention to dissect and release the scar tissue followed by ocular surface reconstruction with conjunctival autograft, amniotic membrane graft, and symblepharon ring placement. This resulted in a reduction in both horizontal and vertical deviations. Post-operative images and measurements shown are 14 months after surgical correction.

Table 1.

Characteristics of patients presenting with diplopia after prior pterygium excision and methods of subsequent repair of diplopia.[a]

Case 10 declined surgical repair and underwent bilateral botulinum toxin injection. The remaining patients underwent dissection of scar tissue and ocular surface reconstruction with placement of amniotic membrane graft (AMG), conjunctival autograft (CAG), or both. A symblepharon ring was placed for all patients with symblepharon. No patients required medial rectus recession

	Case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Gender	F	M	M	M	F	M	F	F	M	M	F	F	F	M	F
	Age	45	64	65	62	55	68	36	24	52	23	56	70	38	32	51
	Total Prior Pterygium Surgeries	3 OS	2 OS	1 OD	1 OD	1 OD	2 OD	1 OD, 1 OS	3 OS	2 OD, 1 OS	1 OD, 1 OS	2 OD, 1 OS	1 OS	3 OS	4 OD	4 OD, 5 OS
	Time to Diplopia (months)	14	2	2	2	1	2	4	7	12	1	6	11	3	20	1.5
	Graft Type	AMG (G)	AMG (S), CAG (S)	AMG (S, G), CAG (S)	AMG (S), CAG (S)	AMG (S), CAG (S)	AMG (S), CAG (S), BMG (S)	CAG (S)	AMG (S, G), CAG (S)	AMG (S), CAG (S)	NA	AMG (S), CAG (S)	AMG (S), CAG (S)	AMG (S)	AMG (S)	AMG (S), CAG (S)
	Muscle Surgery	N	N	N	N	N	Y (RSO Re-Placement)	Y (RLR Resection)	N	N	N	N	N	N	N	N
Diplopia Repair	Symblepharon	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y

[a] Abbreviations: F=Female; M=Male; AMG=Amniotic Membrane Graft; CAG=Conjunctival Autograft; BMG=Buccal Mucosal Graft; G=Glue; S=Suture; NA=Not Applicable; N=No; Y=Yes; RSO=Right Superior Oblique; RLR=Right Lateral Rectus

Table 2.

Preoperative and postoperative measurements for patients undergoing repair of diplopia following prior pterygium excision.[a]

Repair of diplopia was achieved with scar tissue dissection by a strabismologist and ocular surface reconstruction by an oculoplastic surgeon.

	Affected Eye	Primary Position		Right Gaze		Left Gaze		Upward Gaze		Downward Gaze		Reading		Abductive Gaze		Version (−4 to +4)	
Case		Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop	Preop	Postop
1	OS	E2	Unk	Ortho	Unk	ET14, RHT2	Unk	Flick E	Unk	Flick E	Unk	Ortho	Unk	ET14, RHT2	Unk	−1 (ab) OS	−1 (ab) OS
2	OS	ET10, RHT3	Ortho	ET10, RHT3	Flick RH	ET16, RHT8	ET6, RHT2	ET10, RHT5	Ortho	ET10, RHT3	Ortho	ET’8, RHT’4	Ortho	ET16, RHT8	ET6, RHT2	−1 (ab) OS	−1/2 (ab) OS
3	OD	E(T)16, LHT2	Unk	ET25, LHT8	Unk	LHT2	Unk	E(T)14, LHT2	Unk	ET14	Unk	E’2	Unk	ET25, LHT8	Unk	−2 (ab), −1/2 (sup) OD	−1/2 (ab) OD
4	OD	Ortho	Ortho	ET10	E(T)2	Ortho	XT6	Ortho	Ortho	Ortho	Ortho	X’2	Ortho	ET10	E(T)2	−1/2 (ab) OD	−1 (ab) OD
5	OD	Ortho	Ortho	ET16, LHT3	ET10	Ortho	Ortho	Ortho	Ortho	Ortho	Ortho	Ortho	Ortho	ET16, LHT3	ET10	−1 (ab) OD	−1/2 (ab) OD
6	OD	Ortho	Ortho	ET10, RHT2	ET2	XT18, RHT2	XT3	LHT5	Ortho	RH3	Ortho	RH’2	Flick X	ET10, RHT2	ET2	−1 (ab), −1 (inf), −1.5 (sup), −2 (ad) OD	−1/2 (sup), −1/2 (ad) OD
7	OD	ET25	E(T)8	ET30	E(T)10	ET30	E(T)8	ET25	E(T)8	ET25	E(T)8	ET’20	E(T)’20	ET30	E(T)10	−1/2 (ab) OD	Full OU
8	OS	E2	Ortho	E1	Ortho	ET10	E(T)4	E3	Ortho	E2	Ortho	E’2	Ortho	ET10	E(T)4	−1/2 (ab) OS	−1/2 (ab) OS
9	OD	ET10, RHT2	Ortho	ET18, RHT2	Ortho	ET16	Ortho	ET18, RHT2	Unk	ET18, RHT3	Unk	ET’12, RHT’3	Unk	ET18, RHT2	Ortho	−1/2 (ab) OD	Full OU
10	OU	ET25–30	E(T)16	ET25	E(T)14	ET 30–35	E(T)16	ET30	E(T)14	ET25	E(T)16	E(T)’25	E(T)’25	ET25 OD, ET30–35 OS	E(T)14 OD,E(T)16 OS	−1/2 (ab) OU	Full OU
11	OD	E(T)8	ET2	ET20–25	ET10	E(T)6	ET2	E(T)8	ET2	E(T)6	ET2	E(T)’2	Ortho	ET20–25	ET10	−1 (ab) OD	−1/2 (ab) OD
12	OS	Ortho	Ortho	Ortho	Ortho	ET6	Ortho	Ortho	Ortho	Ortho	Ortho	Ortho	Ortho	ET6	Ortho	−1/2 (ab) OS	Full OU
13	OS	Ortho	Unk	Ortho	Unk	ET16	Unk	ET6, RHT2	Unk	E2	Unk	E’2	Unk	ET16	Unk	−1/2 (ab) OS	Full OU
14	OD	ET25	Ortho	ET25	ET7	ET14	Ortho	ET25	Ortho	ET20	Ortho	ET!16	Ortho	ET25	E(T)7	−1 (ab) OD	−1/2 (ab) OD
15	OD	ET14	Unk	ET12	Unk	ET2	Unk	ET14	Unk	ET14	Unk	ET’2	Unk	ET12	Unk	−1/2 (ab) OD, −1/2 (ab) OS	Full OD, −1/2 (ab) OS

[a] Abbreviations: Preop=Preoperative; Postop=Postoperative; E=Esophoria; ET=Esotropia; RHT=Right Hypertropia; E(T)=Intermittent Esotropia; LHT=Left Hypertropia; Ortho=Orthotropic; XT=Exotropia; X=Exophoria; Unk=Unknown; ab=abduction; sup=supraduction; inf=infraduction; ad=adduction; OD=Oculus Dexter (Right Eye); OS=Oculus Sinister (Left Eye); OU=Oculus Uterque (Both Eyes)