Case report

Traumatic chorioretinitis sclopetaria: Risk factors, management, and prognosis

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ABSTRACT

Purpose: To describe new cases of sclopetaria and evaluate the risk factors, management, and visual prognosis of all reported cases in the literature.

Observations: We performed a retrospective, observational case series. This study included six cases (median age 23, interquartile range 33) of sclopetaria. Additionally, literature searches were conducted in the PubMed and Cochrane Library databases to uncover risk factors associated with all published cases of sclopetaria. Main outcome measure was best corrected visual acuity (BCVA) worse than 20/20. Thirty-seven cases (71 eyes) of sclopetaria have been reported, of which 59 cases (61 eyes) met inclusion criteria in this study. Most were young (median age 19.5 years) men (51/59, 88.1%). Thirty-seven eyes were observed while 24 underwent immediate surgery including six pars plana vitrectomies and three scleral buckles. Compared to initial presentation, BCVA improved in 31/48 (64.6%) eyes, remained stable in 12/48 eyes (25.0%), and worsened in 5/48 eyes (10.4%). Ten patients (16.4%) achieved a final BCVA of 20/20 with median follow up time of seven months. In a multivariate model, location of sclopetaria in the macula, temporal retina, or immediate orbital foreign body removal predicted poor final BCVA with an area under receiver operating characteristic curve of 0.767.

Conclusions and importance: Traumatic chorioretinitis sclopetaria is rare, but reports have increased dramatically over the past two decades. While pars plana vitrectomy may be required for the management of retinal detachments and non-clearing vitreous hemorrhage, close observation is appropriate in most cases. Visual prognosis is poor with most patients attaining 20/200 vision or worse.

1. Introduction

Sclopetaria chorioretinitis is the rupture of the choroid and underlying neurosensory retina secondary to a high velocity-projectile adjacent to but not penetrating the globe. The term is thought to originate either from the term sclérotum linked to the name of an old Italian handgun or from the term sclow meaning scratch, pull, or tear. Sclopetaria is a rare condition, yet, an increasing number of cases have been reported in the literature over the last several decades – from 11 cases reported between 1980 and 1999 to 43 reported between 2000 and 2018.

The sequelae of sclopetaria were first described in 1872 by Herman Cohn, a German ophthalmologist. He described a 23-year-old male gunshot victim who, following enucleation, was found to have fusion of the retina and choroid in the posterior pole, so he termed the condition “chorioretinitis.” Subsequently, in 1901, a Hungarian ophthalmologist, Wilhelm Goldzieher, first used the term “chorioretinitis plastica sclopetaria” to describe the fundus findings following a periorbital bullet wound. He noted that the force of the bullet likely caused rupture of the choroid, hemorrhage and ultimately a whitish reactive fibroglial proliferation. The histopathologic findings would later be validated by Dubovy et al. on postmortem examination of the eye of a gentleman shot in 1974. On histopathology, the macula showed defects in Bruch’s membrane and the choroid, extensive photoreceptor loss, and hyperplasia of the retinal pigmented epithelium (RPE). The retina and choroid were replaced with dense and loose fibrous tissue respectively. Most recently, photoreceptor degeneration and decreased cellularity in the retinal ganglion cell layer have been demonstrated in mouse models following blast traumatic brain injury.

Given the low incidence of sclopetaria, consensus on management has not been reached as both observation and immediate surgical management have been described. In this study, we report on six new...
patients with sclopetaria and describe their treatment outcomes. Moreover, to better understand the risk factors, management, and prognosis, we performed a comprehensive review of all reported cases of sclopetaria.

2. Methods

An observational, retrospective case series was assembled from a single institution (Stanford University). Clinical exams were performed by vitreoretinal specialists (DD, DM, VM). In addition to the case series, the PubMed and Cochrane Library databases, most recently in August 2018 were filtered using the search terms sclopetaria, traumatic choriotretinal rupture, choriotretinitis proliferans, retinitis proliferans, and traumatic proliferative chorioretinitis of LaGrange. This search was limited to human studies. The search revealed 77 articles and was narrowed to 33 publications on the topic of sclopetaria. Studies were then excluded that noted sclopetaria but did not distinguish management by individual cases. 20 Twenty-three articles (including the present study) were selected for further review based on inclusion of information regarding immediate management and final best corrected visual acuity (BCVA).

Data recorded from the publications included demographic data, injury details, location of sclopetaria, orbital comorbidities, complications, and immediate and delayed management. BCVA was also converted post-hoc to logarithm of the minimum angle of resolution (logMAR) units to allow for comparative analysis.

Data were analyzed using Statistical Analysis Software Enterprise Guide version 7.13 (SAS Institute, Cary, North Carolina). Variables were tested for normality with the Kolmogorov-Smirnov test to determine the appropriate statistical test. Bivariate testing was used to compare subgroups with poor final BCVA (defined a priori as worse than 20/20) to those with final BCVA of 20/20. Exposure variables were excluded if they were missing. Missing variables comprised less than 10% of the sample except for primary location of sclopetaria (18/61, or 29.5% missing), initial BCVA (12/61, or 19.7% missing) and follow up time (10/61, or 16.4% missing). There were no missing outcome data. A multivariable logistic regression model was developed to determine factors most predictive of a poor final BCVA. Predictors were included if they showed an association (p < 0.10) with poor final BCVA in crude bivariate analysis. Prediction of poor final BCVA was evaluated using the area under receiver operating characteristic curve (AUROC). Variables were considered to be significant by Bonferroni corrected α-levels of less than 0.003 (0.05/20).

3. Findings

3.1. Case 1

A 13-year-old male presented after he was shot near the left eye with a BB gun while playing with friends. His BCVA was 20/25 OD and 20/70 OS. His intraocular pressure (IOP) was 14 mmHg OD and 10 mmHg OS. Both pupils were round and reactive to light without relative afferent pupillary defect (rAPD). On the left, he had a three-by-three-millimeter partial thickness conjunctival laceration that was siedel negative and 4 + red blood cells in the anterior chamber. His posterior segment exam was notable for commotio retinae throughout the macula and periphery with vitreous hemorrhage inferiorly and nasally. There was a choroidal hemorrhage with overlying sclopetaria nasally (Fig. 1). Computed tomography scan (CT) revealed a metallic foreign body in the posterior left ethmoid air cells with mild irregularity of the left lamina papyracea. The patient was managed medically with follow up two days after discharge then again at 1, 3, 5, 7, and 11 weeks. Visual acuity remained stable OD but worsened to counting fingers (CF) at one foot OS at 11 weeks secondary to vitreous hemorrhage and large preretinal hemorrhages inferiorly and nasally. Serial B-scan ultrasonography did not show evidence of retinal breaks or detachments.

3.2. Case 2

A 17-year-old male was assaulted on his way home from school by an unknown male with a BB gun. He presented to the emergency room with BCVA of hand motion OD and 20/20 OS. He had a right rAPD and his visual fields were limited inferiorly. There was an entry wound of the upper eyelid. He had a three-millimeter superonasal conjunctival laceration, microhyphema, and round, non-reactive iris. Posterior segment exam was limited by dense vitreous hemorrhage, but B-scan ultrasonography showed no evidence of tears or detachments (Fig. 2). CT showed the BB adjacent to the optic nerve. He underwent urgent orbital exploration with removal of the BB. One week later, the patient was found to have bernin's edema and a fibroglial scar with sharp serrated borders consistent with scloptetaria superiorly. An adjacent localized rhegmatogenous retinal detachment (RRD) was also seen. Optical coherence tomography (OCT) showed rupture through the choroid, RPE and outer retina. Two weeks after presentation, he underwent 25-gauge pars plana vitrectomy (PPV) for RRD repair with endolaser, perfluorocarbon, and gas tamponade. At five months, he was count fingers at two feet in the right eye.

3.3. Case 3

A 63-year-old man suffered a rifle injury to the left eye when the weapon backfired. Presenting BCVA was 20/20 OD and CF at four feet OS. His IOP was 21 mmHg OD and 23 mmHg OS. He had a left rAPD. Examination of the left eye demonstrated a conjunctival laceration without scleral involvement, a corneal epithelial defect, microhyphema and dense vitreous hemorrhage. Plain film showed no metal foreign body and CT showed no orbital or canal fractures. One month later, the patient's visual acuity returned to 20/20 OU. The rAPD resolved and there was clearing of the vitreous hemorrhage. Wide angle photography revealed an area of bare sclera and of subretinal fibrosis consistent with sclopetaria (Fig. 3). Fluorescein angiography showed no leakage on early frames and staining of the fibrogliotic lesions on late frames.

3.4. Case 4

A 33-year-old man presented following a gunshot wound at close range to his right supraorbital region. CT showed fractures of the right frontal bone, medial orbital wall, and ethmoid sinuses with bullet fragments in the extraconal space and bilateral frontal and ethmoid sinuses (Fig. 4). BCVA was 20/400 OD and 20/20 OS. Intraocular pressure was 53 mmHg OD and 19 mmHg OS, necessitating lateral canthotomy and cantholysis reducing the IOP to 15 mmHg OD. A RAPD was present on the right. His extraocular movements were limited in all directions OD with complete ptosis. A subcentimeter entry wound was noted in the right medial brow. The posterior segment exam showed inferior subretinal hemorrhages, a raised periocular lesion, an infra-temporal crescent of commotio retinae, and superior hemorrhages. OCT four days following the accident showed a full-thickness rupture through the retina, RPE, Bruch's, and choroid consistent with sclopetaria. His BCVA at that time was stable. He underwent conservative management and did not return to clinic for follow-up appointments at one or three months.

3.5. Case 5

A 23-year-old male presented after a self-inflicted shotgun wound to the face. CT scan showed bilateral LeFort III fractures with metallic fragments adjacent the right optic nerve. He had no light perception (NLP) vision in both eyes and IOPs were 10 mmHg on the right and unmeasurable on the left. He had a complex ruptured globe of the left eye with complete extrusion of globe contents ultimately requiring enucleation. In the right eye he had dense vitreous hemorrhage, temporal commotio retinae, and elevation of the retina superiorly. There
was an extensive area of sclopetaria with subhyaloid and intra-retinal hemorrhages in the posterior pole. The retina was attached, but B-scan ultrasonography showed extensive retinal and choroid thickening. He was followed closely while inpatient. Following discharge from the psychiatry unit, four months after the initial incident, he was seen in Retina clinic and found to have a white macula with areas of hemorrhage and macerated tissue with large areas of atrophy and scleral exposure in both the macula and periphery. B-scan ultrasonography showed a tractional elevation of the retina with extensive necrotic appearing tissue. The decision was made to pursue ophthalmic comfort care and globe salvation.

3.6. Case 6

A 69-year-old male presented to the Retina service for new floaters in the setting of a chorioretinal lesion and prior herpes zoster ophthalmicus. He reported a history of BB gun injury to the right eye in childhood without any subsequent surgeries. His BCVA was 20/25 OD and 20/20 OS. His right cornea had a central opacity and with an otherwise normal anterior segment exam. On fundus examination he had pigmentation and chorioretinal atrophy of the nasal quadrant in an area of previous sclopetaria (Fig. 5). OCT showed a normal foveal contour without cystoid macular edema or subretinal fluid in either eye. No intervention was required.
4. Review of the literature

To date, 71 eyes with sclopetaria in 67 patients (including six in the present study) have been described in the literature. Ten eyes were excluded from this review as there was no description of the management and/or final reported BCVA. Of the 59 patients (61 eyes) meeting inclusion criteria in this review, 52 (88.1%) were male (Table 1). The median age at presentation was 19.5-years-old (interquartile range (IQR), 12 years). Where sidedness was reported, 33 were right eyes (60.0%). Patients diagnosed with sclopetaria were most likely to have been injured via indirect trauma to the globe with a BB...
Primary location of sclopetaria in 43 eyes with sclopetaria.

Table 1
Baseline characteristics of all patients in the literature with sclopetaria.

| Characteristic                              | Overall Frequency (%) | Final BCVA Worse Than 20/20, Frequency (%) | Relative Risk (95% CI) | Unadjusted P Value |
|---------------------------------------------|-----------------------|--------------------------------------------|------------------------|-------------------|
| Age at Injury Greater Than or Equal to 18   | 34/59 (57.6)          | 26/34 (76.5)                               | 0.83 (0.67–1.04)       | 0.099             |
| Male Sex                                    | 52/59 (88.1)          | 43/52 (82.7)                               | 0.96 (0.70–1.34)       | 0.830             |
| Right Eye*                                  | 33/55 (60.0)          | 29/55 (87.9)                               | 1.21 (0.91–1.61)       | 0.194             |
| Mechanism of Injury*                        |                       |                                            |                        |                   |
| BB                                          | 23/60 (38.3)          | 21/23 (91.3)                               | 1.16 (0.94–1.44)       | 0.140             |
| Bullet                                      | 16/60 (26.7)          | 12/16 (75.0)                               | 0.87 (0.64–1.18)       | 0.367             |
| Air-gun pellet                              | 5/60 (8.3)            | 5/5 (100.0)                                | 1.22 (1.08–1.38)       | 0.002             |
| Miscellaneous metal object (Nuzzle, Rod, Foreign body from blast, Nail, Sinker) | 5/60 (8.3) | 5/5 (100.0)                               | 0.70 (0.34–1.45)       | 0.338             |
| Painball                                    | 4/60 (6.7)            | 4/4 (100.0)                                | 1.22 (1.08–1.38)       | 0.002             |
| Shotgun pellet                              | 4/60 (6.7)            | 2/4 (50.0)                                 | 0.58 (0.32–1.56)       | 0.284             |
| Cork                                        | 1/60 (1.7)            | 1/1 (100.0)                                | 1.20 (1.07–1.35)       | 0.002             |
| Foam bullet                                 | 1/60 (1.7)            | 1/1 (100.0)                                | 1.20 (1.07–1.35)       | 0.002             |
| Tree branch                                 | 1/60 (1.7)            | 1/1 (100.0)                                | 1.20 (1.07–1.35)       | 0.002             |

* Eighteen patients had missing location data.

** Relative risks calculated for each projectile relative to any other projectile.

BCVA = best corrected visual acuity.

(23/60, 38.3%) or bullet (16/60, 26.7%). However, direct trauma to the globe with subsequent sclopetaria was also reported with paintballs, a tree branch, foam bullet, and cork.

Initial BCVA was NLP to 20/1000 in 35/49 (71.4%), 20/800 to 20/200 in 7/49 (14.3%), 20/100 to 20/25 in 5/49 (10.2%), and 20/20 in 2/49 (4.1%). Final BCVA was NLP to 20/1000 in 30/61 (49.2%), 20/800 to 20/200 in 7/49 (14.3%), 20/100 to 20/25 in 5/49 (10.2%), and 20/20 in 2/49 (4.1%). Where both initial and final BCVA were recorded, BCVA improved in 31/49 (63.3%) eyes, remained stable in 13/48 eyes (26.5%), and worsened in 5/48 eyes (10.2%).

Backward selection was performed on the following variables as possible risk factors for poor BCVA: age, projectile (air-gun, paintball, cork, foam bullet, tree branch), location of sclopetaria in the macula, temporal retina, superior retina, comorbidities (retrobulbar hematoma, eyelid laceration, ptosis, cataract, hyphema or microhyphema, macular hole, maculopathy, optic nerve avulsion) and urgent management (foreign body removal, muscle reattachment surgery, fracture repair, lateral canthotomy, lensectomy). Location of sclopetaria in the macula, location in the temporal retina, and urgent foreign body removal were retained in the model. Area under receiver operating characteristic curve was 0.767, and 10-fold cross validation revealed a true AUROC of 0.737. Therefore, the over-optimism was 0.030, indicating a low degree of overfitting.

6. Discussion

In 1996, Kuhn et al. presented a standardized classification for ocular trauma with the major delineation between closed globe and open globe injuries. The most common comorbidity was intraorbital foreign bodies in 40/61 (65.6%) cases (Table 3). Vitreous hemorrhage occurred in 38/61 (62.3%) cases and typically occurred at the time of injury, though was a delayed complication in three cases - reported at three days, six weeks, and four months. Optic neuropathy (17/61, 27.9%) and hyphemas or microhyphemas (17/61, 27.9%) were also common. Of the seven with subsequent RDs, one was diagnosed at the time of initial injury with the remaining six occurring at one week, one week, two weeks, three weeks, one year, and one and one-half years. Retroluobar hematomas (RR, 1.20; 95% CI 1.07–1.34), eyelid lacerations (RR, 1.24; 95% CI 1.08–1.41), ptosis (RR, 1.20; 95% CI 1.07–1.34), macular holes (RR, 1.23; 95% CI 1.08–1.39), maculopathy (RR, 1.23; 95% CI 1.08–1.39), and optic nerve avulsion (RR, 1.21; 95% CI 1.08–1.37) were all associated with a higher risk of poor BCVA, while, RD was not (RR, 1.04; 95% CI 0.75–1.44).

Regarding management, 36 eyes were observed, seven underwent globe exploration, six urgent PPV, six urgent foreign body removal, three scleral buckle, two enucleation, one prophylactic scleral buckle, one macular hole repair, one lensectomy, one muscle reattachment surgery, one fracture repair, and one conjunctival closure (Table 4). The six patients who underwent urgent PPV had similar outcomes to those observed, with poor final BCVA in five patients (83.3%). Of those undergoing urgent PPV, five had improvement in final BCVA (83.3%).

5. Prediction model

Backward selection was performed on the following variables as possible risk factors for poor BCVA: age, projectile (air-gun, paintball, cork, foam bullet, tree branch), location of sclopetaria in the macula, temporal retina, superior retina, comorbidities (retroluobar hematoma, eyelid laceration, ptosis, cataract, hyphema or microhyphema, macular hole, maculopathy, optic nerve avulsion) and urgent management (foreign body removal, muscle reattachment surgery, fracture repair, lateral canthotomy, lensectomy). Location of sclopetaria in the macula, location in the temporal retina, and urgent foreign body removal were retained in the model. Area under receiver operating characteristic curve was 0.767, and 10-fold cross validation revealed a true AUROC of 0.737. Therefore, the over-optimism was 0.030, indicating a low degree of overfitting.
compressive forces along with its adherent choriocapillaris leading to the late pigmentary changes often seen with both choroidal rupture and retinal detachment.32 Bruch’s membrane is inelastic and ruptures easily with compressive forces. Therefore, only a high velocity projectile, such as a bullet, passing adjacent to the globe, could create the shock wave forces that result in the acute subretinal hemorrhages often seen in ocular trauma. Similarly, the RPE is relatively inelastic, making rupture more likely and leading to the late pigmentary changes often seen with both choroidal rupture and scotepetria. Conversely, both the retina and sclera are elastic, requiring high levels of impact energy to disrupt their architecture. Therefore, only a high velocity projectile, such as a bullet, passing adjacent to the globe, could create the shock wave forces that could produce retraction of both the retina and choroid, leaving bare sclera at the site of a break.38

Regarding long term complications, commotio retinæ can be observed as retinal edema almost universally resolves in a few days.33 Eyes with choroidal rupture must be observed more closely for the potential development of long-term complications such as late macular holes and retinal detachments.32,34

### Table 3

| Comorbidity                        | Frequency | Final BCVA Worse Than 20/20 | Relative Risk (95% CI) | Unadjusted P Value |
|------------------------------------|-----------|----------------------------|-------------------------|-------------------|
| **Orbit/Globe**                     |           |                           |                         |                   |
| Orbital Fracture                   | 11/61 (18.0) | 10/11 (90.9)               | 1.11 (0.88–1.39)        | 0.374             |
| Motility deficit                   | 4/61 (6.6) | 3/4 (75.0)                 | 0.56 (0.05–6.03)        | 0.694             |
| Retrolental Hematoma               | 1/61 (1.6) | 1/1 (100.0)                | 1.20 (1.07–1.34)        | 0.002             |
| **Anterior Segment**               |           |                           |                         |                   |
| Hyphema/Microhyphema               | 17/61 (27.9) | 16/17 (94.1)               | 1.18 (0.98–1.43)        | 0.085             |
| Conjunctival Laceration            | 12/61 (19.7) | 10/12 (83.3)               | 1.00 (0.75–1.32)        | 0.977             |
| Eyelid Laceration                  | 9/61 (14.8) | 9/9 (100.0)                | 1.24 (1.08–1.41)        | 0.002             |
| Corneal Abrasion/Epithelial Defect/Corneal Edema/Corneal Laceration | 5/61 (8.5) | 4/5 (80.0)                | 0.96 (0.61–1.51)        | 0.860             |
| Iridodialysis/Angle Recession      | 2/61 (3.3) | 1/2 (50.0)                 | 0.59 (0.15–2.37)        | 0.457             |
| Elevated Intraocular Pressure      | 2/61 (3.3) | 1/2 (50.0)                 | 0.59 (0.15–2.37)        | 0.457             |
| Prostis                            | 1/61 (1.6) | 1/1 (100.0)                | 1.20 (1.07–1.34)        | 0.002             |
| Sclerolysis Lens                   | 1/61 (1.6) | 0/1 (0.0)                  | 0.30 (0.03–3.27)        | 0.221             |
| Cataraclt                          | 1/61 (1.6) | 1/1 (100.0)                | 1.20 (1.07–1.34)        | 0.002             |
| **Posterior Segment**              |           |                           |                         |                   |
| Intraorbital Foreign Body          | 40/61 (65.6) | 36/40 (90.0)               | 1.26 (0.94–1.68)        | 0.118             |
| Vitreous Hemorrhage                | 38/61 (62.3) | 31/38 (81.6)               | 0.94 (0.75–1.17)        | 0.568             |
| Optic Neuropathy                   | 17/61 (27.9) | 13/17 (76.5)               | 0.89 (0.66–1.18)        | 0.409             |
| Commotio Retinæ                    | 16/61 (26.2) | 15/16 (93.8)               | 1.17 (0.97–1.42)        | 0.108             |
| Retinal Detachment                 | 7/61 (11.5) | 6/7 (85.7)                 | 1.04 (0.75–1.44)        | 0.830             |
| Macular Hole                       | 7/61 (11.5) | 7/7 (100.0)                | 1.23 (1.08–1.39)        | 0.002             |
| Maculopathy                        | 6/61 (9.8) | 6/6 (100.0)                | 1.23 (1.08–1.39)        | 0.002             |
| Optic Nerve Avulsion               | 4/61 (6.6) | 3/3 (100.0)                | 1.21 (1.08–1.37)        | 0.002             |

BCVA = best corrected visual acuity.

*a* Variables considered to be significant by Bonferroni corrected a-levels of 0.003 (0.05/20).

### Table 4

| Immediate Surgery                  | Frequency (%) | Final BCVA Worse Than 20/20, Frequency (%) | Relative Risk (95% CI) | Unadjusted P Value |
|------------------------------------|---------------|-------------------------------------------|-------------------------|-------------------|
| **Overall**                         |               |                                           |                         |                   |
| **Any Immediate Surgery**          | 24/61 (39.3)  | 22/24 (91.7)                              | 1.17 (0.95–1.44)        | 0.140             |
| Observation                        | 37/61 (60.7)  | 29/37 (78.4)                              | 0.86 (0.69–1.05)        | 0.140             |
| Foreign Body Removal (Non-Intraocular) | 8/61 (13.1)  | 8/8 (100.0)                               | 1.23 (1.08–1.40)        | 0.002             |
| Globe Exploration                  | 7/61 (11.5)   | 6/7 (85.7)                                | 1.03 (0.74–1.42)        | 0.865             |
| Pars Plana Vitrectomy              | 6/61 (9.8)    | 5/6 (83.3)                                | 1.00 (0.68–1.45)        | 0.985             |
| Scleral Buckle                     | 3/61 (4.9)    | 2/3 (66.7)                                | 0.79 (0.35–1.77)        | 0.566             |
| Enucleation                        | 2/61 (3.3)    | 2/2 (100.0)                               | 1.20 (1.07–1.35)        | 0.002             |
| Muscle Reattachment Surgery        | 1/61 (1.6)    | 1/1 (100.0)                               | 1.20 (1.07–1.34)        | 0.002             |
| Fracture Repair                    | 1/61 (1.6)    | 1/1 (100.0)                               | 1.20 (1.07–1.34)        | 0.002             |
| Lateral Canthotomy                 | 1/61 (1.6)    | 1/1 (100.0)                               | 1.20 (1.07–1.34)        | 0.002             |
| Lensectomy                         | 1/61 (1.6)    | 1/1 (100.0)                               | 1.20 (1.07–1.34)        | 0.002             |
| **Delayed Surgery**                |               |                                           |                         |                   |
| Any Delayed Surgery                | 9/61 (14.8)   | 7/9 (77.8)                                | 0.92 (0.64–1.33)        | 0.654             |
| Pars Plana Vitrectomy              | 6/61 (9.8)    | 5/6 (83.3)                                | 1.00 (0.68–1.45)        | 0.985             |
| Scleral Buckle                     | 3/61 (4.9)    | 2/3 (66.7)                                | 0.79 (0.35–1.77)        | 0.566             |
| Fracture Repair                    | 2/61 (3.3)    | 1/2 (50.0)                                | 0.59 (0.15–2.37)        | 0.457             |
| Lensectomy                         | 2/61 (3.3)    | 2/2 (100.0)                               | 1.20 (1.07–1.35)        | 0.002             |

BCVA = best corrected visual acuity.

*a* Variables considered to be significant by Bonferroni corrected a-levels of 0.003 (0.05/20).

*b* Defined as less surgery performed less than one week after the injury.
development of secondary choroidal neovascularization membranes. Patients with sclopetaria are at higher risk for both delayed vitreous hemorrhage or progression of vitreous hemorrhage (as in Case 1) and retinal detachment, which has given credence to early surgical intervention.21 Prior to 2014, it was felt that retinal detachment was unlikely to occur in the setting of sclopetaria due to adhesions between the retina and choroid causing them to retract as a single unit. Additionally, as most patients with sclopetaria are young, they have formed vitreous and intact posterior hyaloid which tamponades the retinal break. However, in 2014, Papakostas et al. published three cases of retinal detachment in the setting of sclopetaria.21 It should be noted that these three patients had preceding surgery (globe rupture repair, nail removal, and BB removal from the orbit) prior to retinal detachment. Based on the results of this review, the incidence of retinal detachment following sclopetaria was 11.5% (7/61) though this finding was not associated with a worse visual outcome (p = 0.83).

The visual prognosis following sclopetaria is dependent on multiple features. When considering projectile type, those with the lower muzzle energy (e.g. air-gun pellet and paintball) were more likely to result in poor visual outcome than those with high muzzle energy (e.g. bullet and BB) (Table 1).25 This was a surprising finding as increased muzzle energy is typically associated with increased damage. Therefore, we propose that the visual prognosis is more likely related to the location of sclopetaria and the associated ocular comorbidities than the projectile type. As anticipated, those with temporal and macular sclopetaria were less likely to achieve 20/20 vision (Table 2). Additionally, the concurrence of a macular hole or maculopathy were risk factors for incomplete visual recovery (Table 3). Those with eyelid lacerations were at higher risk for poor visual prognosis, possibly because these tended to occur in the setting of more extensive orbital damage. The presence of an intraorbital foreign body, vitreous hemorrhage and retinal detachments were not independent risk factors for suboptimal visual recovery. As expected, those with simultaneous optic nerve avulsion had poor visual outcomes.

The most controversial component of sclopetaria is the immediate management. As this review has demonstrated, there is no statistically significant benefit of immediate surgery as compared to observation alone (p = 0.140). However, this finding needs to be taken in context as it is unknown what the visual outcome would have been if surgery was delayed. In cases where the clinical suspicion was high for a ruptured globe, globe exploration did not ultimately worsen the chance for visual recovery (p = 0.865). Additionally, PPV (6 cases) and/or prophylactic scleral buckle (3 cases) were not statistically beneficial in protecting vision, though the sample size was likely too small to detect a difference. Of the nine patients undergoing delayed surgery, only two ultimately achieved a visual acuity of 20/20. Patients undergoing immediate orbital foreign body removal were statistically less likely to achieve 20/20 vision (p = 0.002). The standard of care following inorganic intraorbital foreign body removal includes observation unless they are causing complications or anteriorly located allowing simple removal as loss of vision is almost always associated with the initial trauma.26 Immediate surgical intervention (especially orbital foreign body removal) is likely not beneficial for ultimate visual recovery, though this decision needs to be tailored to each individual scenario.

### 7. Conclusions

Ultimately, sclopetaria is a rare sequelae of a high velocity projectile passing tangentially to the eye. The demographic associated with sclopetaria is the same as for trauma elsewhere to the body – young males. Sclopetaria most commonly occurs secondary to BBs, likely due to both the common use of BB guns among this population and the impact velocity enough to rupture the retina, but low not to harm the sclera.27,28 The visual prognosis is most dependent on the status of the macula and the location of the sclopetaria (with superior and temporal disease having worse outcomes). The immediate and delayed management is equivocal and a case by case approach is likely the safest approach. Fortunately, most patients experience improvements in final BCVA though only 16.4% achieve 20/20 vision.

### Patient consent

This report does not contain any information that could lead to the identification of the patients.

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### Conflicts of interest

None reported.

### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

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None.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at [https://doi.org/10.1016/j.ajoc.2019.02.004.](https://doi.org/10.1016/j.ajoc.2019.02.004).

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