American Journal of Ophthalmology Case Reports 36 (2024) 102210

Available online 9 November 2024

findings indicating significant choroidal hemorrhage and retinal detachment, it was deemed appropriate to wait for hemolysis before intraocular treatment. An encircling scleral buckle was performed using a silicone circle band #40 and silicone tube #70 (Fig. 2B). To prevent endophthalmitis, ceftazidime (20μg/ml) and vancomycin (40μg/ml) were injected into the vitreous irrigation solution and also into the vitreous body, completing the surgery. Tetanus toxoid and tetanus human immunoglobulin were administered to prevent infection.

On the first postoperative day, the patient had light perception as her visual acuity in the right eye. On the 17th day, we performed cataract surgery with insertion of an intraocular lens (IOL) and pars plana vitrectomy under general anesthesia to address the choroidal hemorrhage and restore the retina. Using a 25G needle, we inserted it through the sclera into the suprachoroidal space for draining the choroidal hemorrhage (Fig. 2C). In the course of the vitrectomy, the retina was noted to be completely detached, and the upper part of the retina was incarcerated in the laceration (Fig. 2D). The proliferative membrane was removed using a vitreous cutter and vitreous forceps, using triamcinolone for visualizing the vitreous remnants and membranes. Given the challenging adhesion, we performed retinotomy around the entire periphery. The retina was then stretched using liquid perfluorocarbon, followed by retinal photocoagulation. Finally, we directly replaced the perfluorocarbon with silicone oil (SO) (Fig. 2E).

Four days after vitrectomy, the visual acuity was limited to hand motion, and IOP was 4 mmHg in the right eye. The intraocular cavity was filled with SO, although the elevation caused by the choroidal hemorrhage persisted (Fig. 3A–D, G). Over time, the choroidal hemorrhage gradually decreased, and the proportion of SO in the eye decreased accordingly (Fig. 3B–E, H). Twelve months after the second surgery, the right best corrected visual acuity was 20/60 (−3.0D −6.0D x 180) and the left best corrected visual acuity was 20/12 (−1.5D) by auto-refraction. The amount of SO decreased to approximately 60 % with the absorption of the choroidal hemorrhage, and the IOP was 7 mmHg in the right eye and 12 mmHg in the left eye with no retinal detachment (Fig. 3C–F, I).

3. Discussion

OGI resulting from a brown bear attack often leads to blindness, with a notably poor visual prognosis.[4] Even if the ocular morphology can be preserved, maintaining visual function becomes challenging when RD or proliferative vitreoretinopathy (PVR) develops. Infection is also a major problem in animal-induced trauma.[3]

In this case, the patient underwent an encircling scleral buckle first, and a vitrectomy approximately two weeks after the dissolution of the choroidal hemorrhage. There is no reported case in which the retina was restored after total RD due to a brown bear attack and good visual acuity was achieved.

The standard approach to treating OGI is primary repair to restore the structural integrity of the globe at the earliest opportunity. RD following OGI often requires multiple surgeries, and the initial intervention is crucial, as each subsequent surgery introduces inflammation and complicates manipulation.[5] OGI may be accompanied by retinal tears, or the vitreous may prolapse from the eye, exerting traction on the

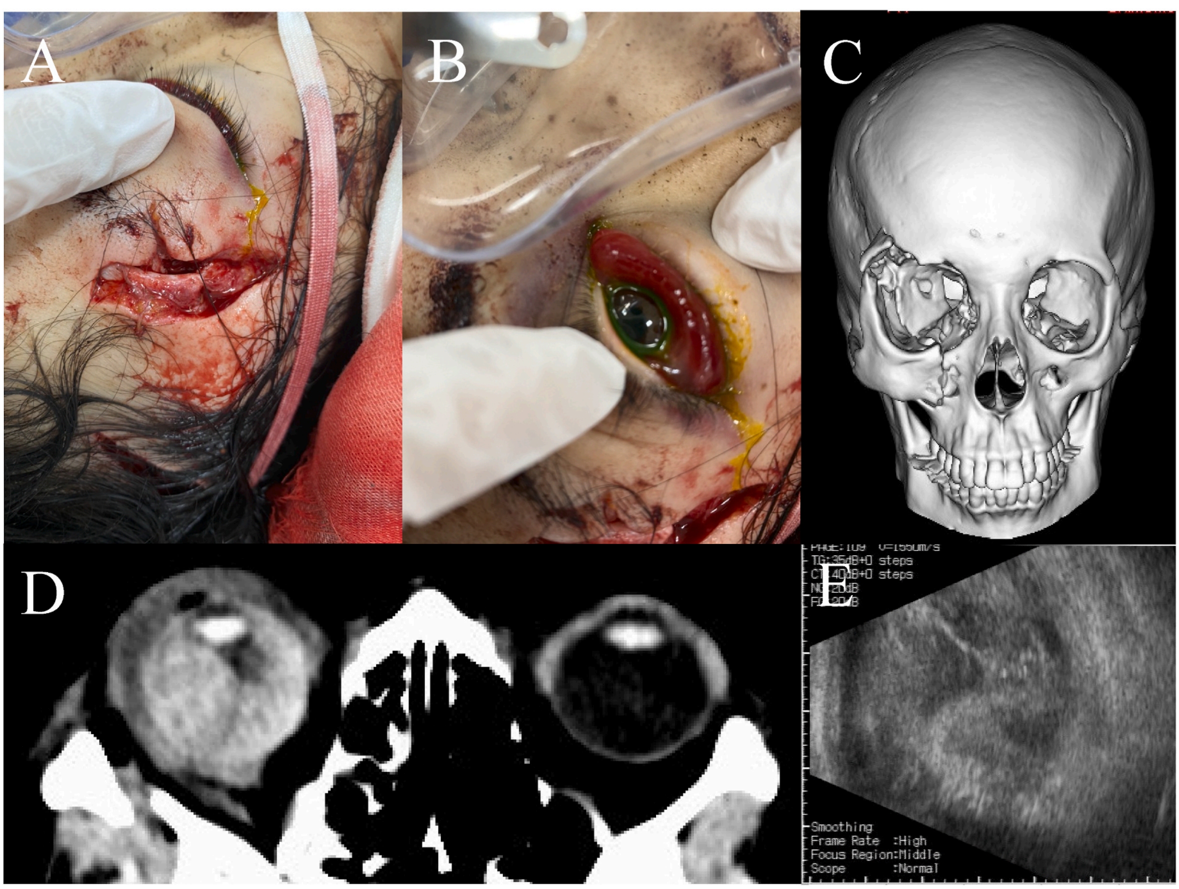

Fig. 1. Images of the right eye obtained following of the brown bear attack. There were lacerations and open fractures of the right temporal region of the face (**A**). The patient was seen in the emergency room, and a slit-lamp examination was performed with the patient in the supine position, revealing marked subconjunctival hemorrhage and hyphema (**B**). A three-dimensional image of the head computed tomography (CT) scan demonstrated fractures of the outer orbital walls (**C**). Orbital CT imaging showed hemorrhage in the right eye (**D**). B-mode ultrasonography revealed a convex ridge toward the inside of the eye, which was suspected to be a choroidal hemorrhage and retinal detachment (**E**).

retina. An encircling scleral buckle, by providing support to the retina, can mitigate vitreous traction and the development of postoperative retinal tears and detachments. Retrospective studies have indicated that an encircling scleral buckle during vitrectomy reduces the incidence of postoperative RD compared to procedures without it.[6,7,8,9] In this case, a circumferential conjunctival incision was made during the initial surgery to suture the scleral laceration. At the same time, an encircling scleral buckle was fixed 12mm from the corneal limbus for the purpose of supporting the vitreous base and reducing the risk of PVR. The patient was suspected to have choroidal hemorrhage and rhegmatogenous RD during the preoperative examination, and a two-stage approach was anticipated.

The optimal timing of vitrectomy for OGI is a matter of controversy. However, Mansouri et al. reported that the timing of vitrectomy was not associated with visual outcomes in 90 patients with ocular trauma.[10] Similarly, Ghoraba et al. analyzed 207 eyes of 197 patients with gunshot perforating eye injury and found no statistically significant difference in anatomical or functional results between the two groups of patients who underwent vitrectomy at 3–4 weeks after injury and after 4 weeks.[11] They recommended vitrectomy by the 5th week because RD due to PVR is more likely to occur after the 4th week. However, some studies support early vitrectomy. Chen et al. studied 120 patients with traumatic optic neuropathy.[12] Vitrectomy was performed within one week of injury for the treatment group and after one week for the control group. They reported that early vitrectomy resulted in better visual recovery, fewer complications, and preservation of the retinal nerve fiber layer.

Similarly, a retrospective observational study was conducted to determine the optimal timing of vitrectomy.[13] All cases were categorized based on the timing of vitrectomy following injury into three groups: 1−7 days, 8−14 days, and more than 14 days. These results suggested that the most favorable timing for vitrectomy in cases of OGI was within 8–14 days after injury, followed by 1–7 days, while the least favorable was after 14 days. Performing early vitrectomy on acutely injured eyes could increase the risk of postoperative PVR due to iatrogenic retinal tears if the posterior vitreous detachment (PVD) had not yet occurred. Given that ocular trauma is more common in young males,[14] it is safer to wait until the PVD forms spontaneously. Two weeks after injury, fibrovascular proliferation and inflammation could often lead to contraction. The onset of PVR can range from 1 to 6 months following ocular trauma.[15] The patient underwent vitrectomy on the 17th day. Although the retina was incarcerated into the incision, the fibroproliferative membranes were still manageable to peel and cut during this time, leading to the formation of a PVD. Additionally, a significant choroidal hemorrhage was confirmed by ultrasonography before surgery, and it was anticipated that the vitreous cavity was narrowed. Therefore, we deferred the initial vitrectomy until approximately two weeks after the initial injury to allow time for the choroidal hemorrhage to liquefy.[16]

Although removal of SO is contemplated for the future, many studies have highlighted that eyes with preoperative hypotony are significantly more likely to have persistent hypotony after SO removal.[17,18] It has been reported that the eyes undergoing a 360°retinotomy reduce ciliary body function, resulting in hypotony.[18] The IOL was already inserted because of concerns about deterioration of the corneal condition due to prolonged storage of SO. Given the unequal refractive error, there is no advantage in removing SO.

4. Conclusions

We reported a case of OGI caused by a brown bear attack in which scleral suture and an encircling scleral buckle were performed at the initial surgery to reduce the risk of developing PVR. Choroidal drainage was performed on the 17th day, when hemolysis was expected, and then cataract surgery and vitrectomy were then performed. The patient exhibited a favorable postoperative course with no redetachment. OGIs caused by a brown bear attack often have a poor prognosis, but with proper preoperative diagnosis and treatment, vision preservation may be achievable.

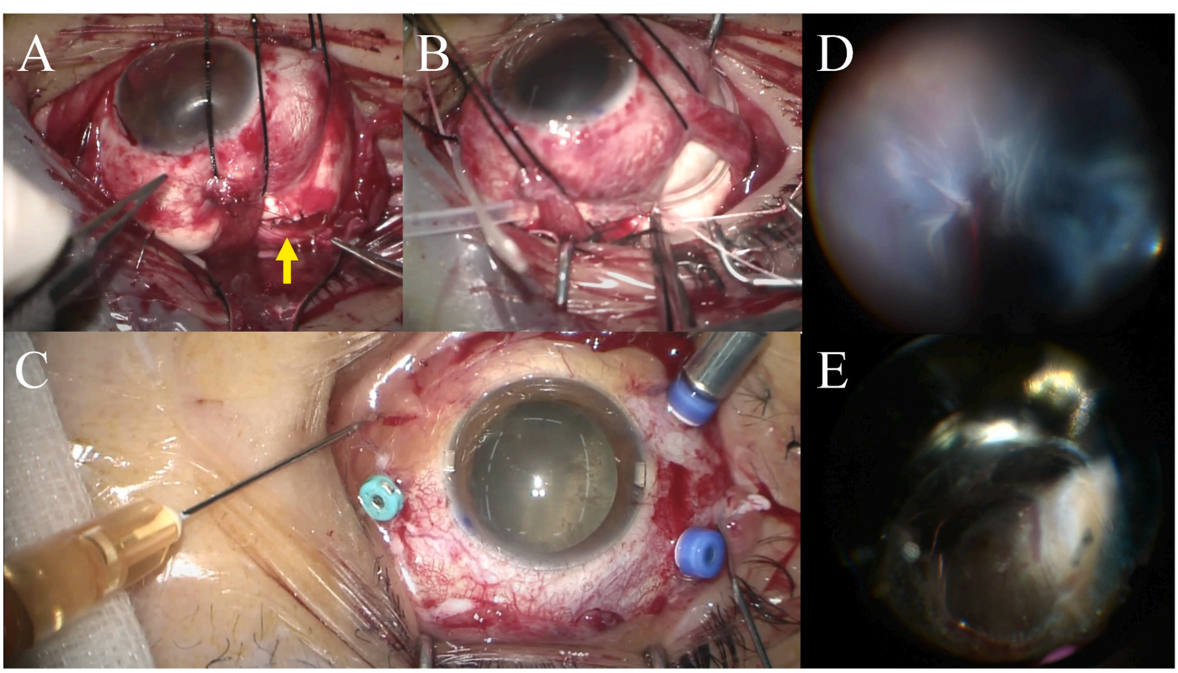

Fig. 2. Images obtained during the first surgery (**A, B**) and the second surgery (**C-E**). A scleral laceration of approximately 15mm from the right superior rectus muscle insertion was observed and sutured with nylon suture (**A**, yellow arrow). Cerclage was also performed using a silicone circle band #40 and silicone tube #70 (**B**). During the second surgery, a 25G pars plana vitrectomy was undergone. 25G needle was inserted through the sclera into the subchoroidal space to drain the choroidal hemorrhage (**C**). During the vitrectomy, the retina was totally detached, and the upper retina was incarcerated into the wound (**D**). Retinotomy was performed around the entire periphery. The retina was stretched with liquid perfluorocarbon, retinal photocoagulation was performed, and direct replacement of perfluorocarbon with silicone oil (SO) was executed (**E**).

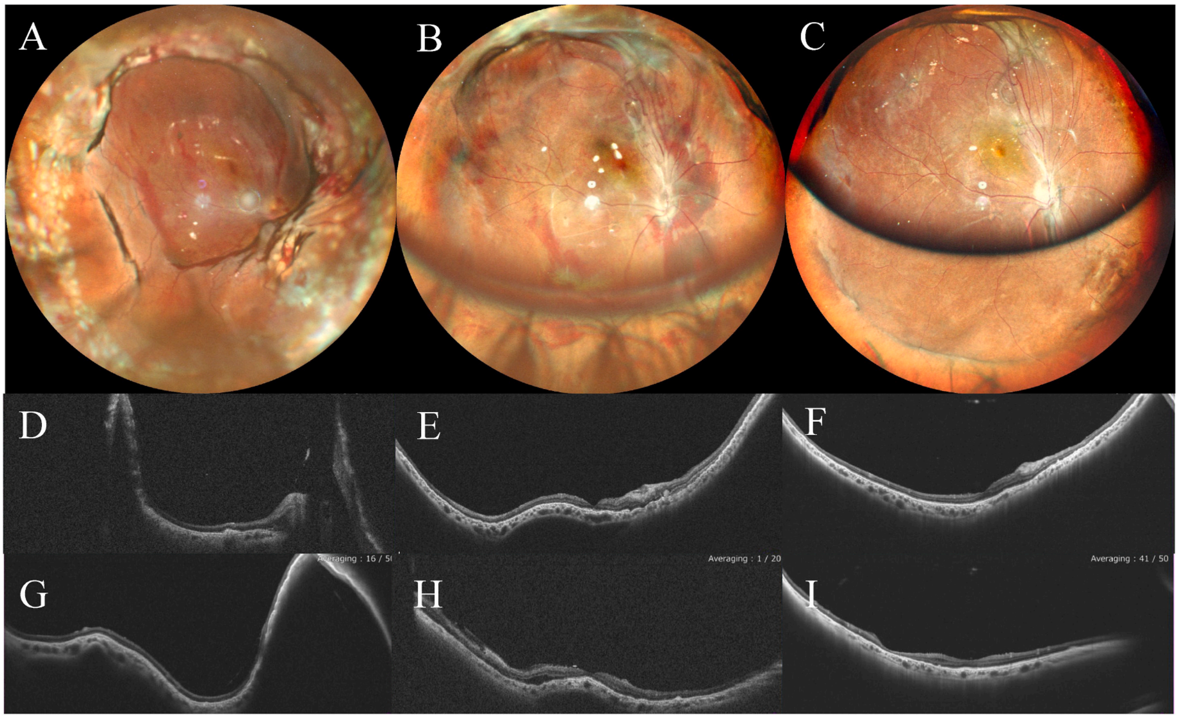

Fig. 3. Color fundus photographs (**A-C**), horizontal (**D-F**) and vertical (**G-I**) optical coherence tomography (OCT) images (Xephilio OCT-S1, Canon, Tokyo, Japan) at the macula following surgery. Four days after vitrectomy, the intraocular cavity was filled with silicone oil (SO), although the elevation caused by the choroidal hemorrhage remained (**A, D, G**). After one month, the choroidal hemorrhage gradually decreased, and the percentage of SO in the eye decreased accordingly (**B, E, H**). Twelve months after surgery, SO had decreased to about 60 % with absorption of the choroidal hemorrhage (**C, F, I**). There was no retinal detachment at any stage.

CRediT authorship contribution statement

Ami Konno: Writing – original draft. **Akihiro Ishibazawa:** Writing – review & editing. **Hiroyuki Kagokawa:** Writing – review & editing. **Yuuki Meya:** Writing – review & editing. **Taiji Nagaoka:** Writing – review & editing.

Patient consent

The patient provided written consent for the publication of the case.

Authorship

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

Funding

None.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

None.

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