Combined brilliant blue G and xenon light induced outer retinal layer damage following macular hole surgery

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We report a case of combined brilliant blue G and endoilluminator retinal toxicity in a patient who has undergone macular hole surgery. The patient developed extensive degeneration of the retinal pigment epithelium as early as 1 week following surgery that eventually lead to poor visual outcome. We look into the pathogenesis of BBG and endoilluminator causing retinal toxicity and also suggest measures to avoid this irreversible retinal damage.

Key words: BBG, macular hole, retinal damage, surgery, toxicity

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Surgical management of a full-thickness macular hole (MH) requires vitrectomy with posterior hyaloid removal, stripping of internal limiting membrane (ILM), and gas tamponade.[1] The peeling of the ILM helps in relieving the tangential traction from the retina and also removes the scaffold for a possible recurrent epiretinal membrane. Vital dyes like indocyanine green, brilliant blue G (BBG) and bromophenol blue have a higher affinity to stain the ILM.[2] Studies have demonstrated the toxic effects of vital dyes, especially indocyanine green on the retinal cells.[3] Studies on BBG have shown promising safety profile compared to indocyanine green after subretinal and intravitreal injections.[2] BBG use showed better final visual and structural outcomes after surgery compared to indocyanine green.[4,5] However, Ambiya *et al*. have reported reduction in the inner retinal layer thickness with use of BBG in MHs.[6] This case report describes an unusual case of macular outer retinal damage following vitreoretinal surgery for full thickness MH and explains the possible role of BBG and endoilluminator in this regard.

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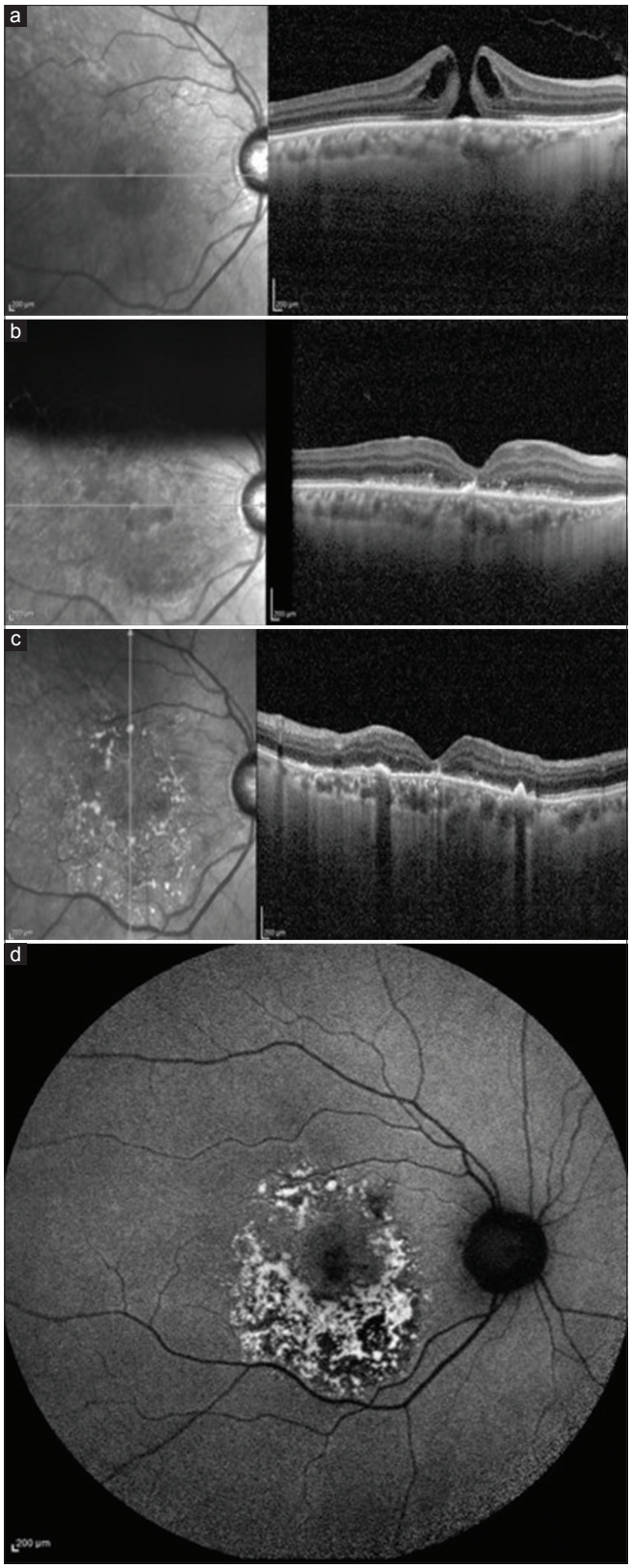

Figure 1: Optical coherence tomography (OCT) and fundus autofluoroscence images of the right eye: (a) At presentation, there is a full thickness macular hole with intraretinal cystoid spaces and intact outer retinal layers in the right eye on OCT. (b) OCT image at 1-week post-surgery showing the damaged retinal pigment epithelial and outer retinal layers. (c) Similar OCT findings are noted at 3 weeks post-surgery. (d) Fundus autofluorescence of the right eye showing a well-defined area of mixed autofluoroscence pattern confirming the damaged outer retinal layers

Case Report

A 65-year-old woman presented to the retina clinic with decreased vision in the right eye for 1 month with visual acuity of 6/24, N18. Fundus examination through the hazy media due to cataract revealed a full thickness MH in the right eye. Left eye examination was normal. Spectral domain optical coherence tomography (OCT) using the Spectralis Heidelberg machine confirmed a full-thickness MH with intraretinal cystoid spaces. The minimum inner diameter and basal diameter of MH was 201 µ and 816 µ respectively along its long axis [Fig. 1a]. Posterior vitreous detachment was present. Macular hole repair along with cataract surgery was recommended which she underwent 10 days after presentation.

A 25-gauge, 3-port pars plana vitrectomy using the Alcon, CONSTELLATION® Vision System was performed. After core vitrectomy, intravitreal triamcinolone acetonide was injected to stain the posterior cortical vitreous. Posterior vitreous detachment was completed. Fluid air exchange was done. ILM was stained using BBG (Ocublue Plus 0.05%w/v, Aurolab) for a contact time of 2 minutes. After 2 minutes, excess BBG was removed passively with flute needle and saline infusion was started. Staining of the ILM seemed inadequate. No epiretinal membrane was visualised intraoperatively. ILM peeling was attempted using the disposable GRIESHABER® asymmetrical forceps using the pinch-pick-peel technique. After multiple failed attempts to lift the ILM edge, it was decided to restain the ILM with BBG under air. Again, contact time of 2 minutes was given. Peeling of the ILM was achieved in a uniform manner. The ILM peel extended superiorly midway between the superior arcade and MH and inferiorly till the inferior arcade. The duration of ILM peeling was prolonged and the total surgery duration was 90 minutes. No other complications were noted intra-operatively. Repeat fluid air exchange was done and 20% sulphur hexafluoride gas was used for endotamponade and prone position was maintained for 7 days. On post-operative day 1, intraocular pressure was normal, retina attached, and the status of MH was difficult to comment. At 1-week follow-up, OCT showed type 1 MH closure with disrupted outer retinal layers [Fig. 1b]. Residual gas bubble (30%) was present. At 3 weeks post-operative follow-up visit, OCT showed a closed MH with damaged outer retinal layers [Fig. 1c]. Fundus autofluoroscence showed a well-defined area of hypo and hyper autofluoroscence [Fig. 1d]. The best-corrected visual acuity deteriorated to 4/60. At 3 months post-surgery, the OCT still showed a type 1 MH closure and visual acuity of 4/60.

Discussion

Retinal damage following MH surgery can occur due to surgical trauma while vitrectomy or ILM peeling,[7] toxicity due to the use of vital dyes like BBG or indocyanine green,[3,4] phototoxicity due to the microscope light or endo illuminator[8] and toxicity due to the inappropriate antibiotic dose in the saline infusion. In this case, no intraoperative complications were noted, and antibiotics were not added to the infusion solution. The damage of the retinal layers in this case was noted primarily to the retinal pigment epithelial (RPE) cells and photoreceptors. The inner retinal layers were normal in structure.

The light absorption properties and emission spectrum of BBG lies between 260 and 900 nm in different solvents. All BBG solutions have double-peak curves. The first peak is noted at 260–280 nm and the second peak occur between 540 and 680 nm. Endoilluminator with wavelength ≥400

nm light induces phototoxic effects mainly in RPE.[9] The CONSTELLATION® Vision System from Alcon uses the xenon light for endo illumination during the vitreoretinal surgeries. Xenon light has a peak wavelength of 450 nm (range 420–700 nm).[10] Vital dyes are small chemical molecules that easily penetrate retina and produces phototoxic free radicals due to changes in emission spectrum after absorption of light. The increased absorption of the xenon light by the BBG and changes in the emission spectra of BBG produces toxic free radicals and subsequent damage to the RPE cells and photoreceptors. *In vitro* studies on the human RPE cells (ARPE-19) have shown that RPE cell viability to reduce in the presence of BBG, focal high illumination used for >5 minutes and medium diffuse illumination used for >15 minutes, respectively.[8,9] To the best of our knowledge, no report describing the RPE and photoreceptor damage following macular hole surgery due to cumulative BBG and xenon light toxicity has been noted in literature. In this case, stripping of the ILM became tedious due to the poor ILM staining. The cumulative damage caused to the RPE cells and photoreceptors due to the repeated use of BBG for longer time to stain the ILM and focal high illumination for longer periods to peel the ILM could have led to the poor visual outcome in this case.

Conclusions

To conclude, a rare case of outer retinal damage following MH surgery due to repeated staining of ILM with BBG and use of high focal xenon light illumination has been described. This report educates the surgeon to be quick and precise while performing macular surgeries. One should avoid repeated staining of ILM with BBG and instead use BBG mixed with isotonic glucose solution at a concentration range of 2.5-10% for better ILM staining. Furthermore, one should avoid the use of high focal illumination close to the macula (<10 mm) to avoid any phototoxic damage to the RPE cells and photoreceptors.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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