

Globe Perforation During Peribulbar Anesthesia: Experience of Half a Million Consecutive Injections

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Research Article

Keywords: Local anaesthesia, Perforation, Peribulbar block, Retinal breaks, Retinal detachment, Retinal vascular occlusions

Posted Date: April 12th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-392648/v1>

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Abstract

Aim: To evaluate the risk factors, clinical presentation, management and outcome of inadvertent globe perforation during peribulbar anaesthesia.

Methods: This retrospective study evaluated the medical records of all the patients treated for globe perforation secondary to peribulbar block preceding ocular surgery from 2012 to 2020. The patients were divided into three groups; Group 1 - clear media with no retinal detachment (RD); group 2 - vitreous hemorrhage (VH) without RD; and group 3 - RD with/without VH.

Results: Twenty-five patients (25 eyes) were identified. The incidence of globe perforation was 0.002 %. The mean axial length (AL) was 24.7 ± 2.7 mm (Range, 20.9-31.2 mm). Eleven eyes (45.8%) had $AL \geq 24$ mm.

The most common presenting features were VH (n=14), ocular hypotony (n=7) and RD (n=7). The treatment included laser photocoagulation for the retinal break(s) (n=7) and vitrectomy (n=17). Retinal breaks were identified in all the patients (total breaks, 37). Other complications included full-thickness macular hole (n=5), subretinal haemorrhage (n=4) and retinal vascular occlusions (n=4).

Mean presenting best-corrected visual acuity (BCVA) in group 1, 2 and 3 were logMAR 0.79 ± 0.73 , 1.82 ± 0.78 and 2.13 ± 0.59 respectively. All the patients, except one who did not undergo surgery due to advanced proliferative vitreoretinopathy, had an attached retina at the time of last follow-up. The mean final BCVA was logMAR 0.59 ± 0.79 , 0.48 ± 0.26 and 1.25 ± 0.64 respectively.

Conclusion: Early intervention can help manage the eyes with inadvertent perforation successfully. The presence of retinal detachment, as well as macular and vascular complications are risk factors for poor prognosis.

Introduction

The akinesia required for ocular surgeries is usually achieved using local anaesthesia. The various methods of achieving this anaesthesia include retrobulbar, peribulbar and subtenon injections. All these methods are quick and highly effective in achieving their aims. However, unfortunately all these procedures are blind and can lead to inadvertent globe perforations.¹⁻³¹

An incidence of 0.006–0.13% for globe perforation after retrobulbar and peribulbar anaesthesia has been reported.^{1,2,9,12,21} This can lead to complications like retinal breaks, subretinal haemorrhage (SRH) around retinal breaks, vitreous haemorrhage (VH), retinal detachment (RD) or endophthalmitis.¹⁻³¹ Inadvertent intraocular injection of the anesthetic agent can be even more dangerous.^{11,17}

This study was done to evaluate the risk factors, clinical presentation, management and outcome of inadvertent globe perforations during peribulbar anaesthesia at a tertiary care ophthalmic institute.

Material And Methods

This was a retrospective study conducted at a tertiary-care eye hospital in South India. The study was conducted with the approval of the Institutional Review Board (Registration No. ECR/182/INST/TN/2013, dated 20.04.2013) and adhered to the tenets of the Declaration of Helsinki. Informed consent was taken from the patients after explaining the nature of surgery and its associated complications.

The medical records of all the patients who were treated for globe perforation secondary to peribulbar block preceding ocular surgery from 2012 to 2020 were reviewed. The patients included both the in-house complications as well those referred from outside. The data reviewed included demographics of the patients; axial length; presenting best-corrected visual acuity (BCVA), intraocular pressure and complete dilated examination; interval between the needle perforation and development of secondary complications; management; final anatomical and visual outcome; and the cause(s) of poor outcome. B-scan ultrasound was done whenever appropriate. All patients were treated by one surgeon (NB).

During the first five years of the study, i.e. from 2012 to 2017, only peribulbar blocks were used. A percutaneous injection of a mixture of bupivacaine, lidocaine, and hyaluronidase was injected using a sharp 25-gauge disposable needle with the patient in supine position and both eyes open. First injection was given at the junction of the medial two-thirds and the lateral third of the lower orbital margin using index finger of the spare hand to push the globe superiorly. In case of inadequate akinesia, a second injection was given at the junction of the medial one-third and lateral two-thirds of the superior orbital margin with index finger of the spare hand to push the globe inferiorly.

During the next three years of the study, i.e. from 2018 to 2020, subtenon blocks were used. Topical anaesthetic drops were used to anaesthetise the conjunctiva followed by Povidone-iodine (5.0%) topical drops to sterilise the conjunctival sac. A small cut was made in the fused conjunctiva and anterior Tenon's capsule in the infero-nasal quadrant, 7–10 mm from the limbus, to access the sub-Tenon's space. Blunt dissection was then done using Westcott scissors to space a thin channel in the posterior sub-Tenon's space till the globe equator. A mixture of bupivacaine and lidocaine was injected using a blunt disposable cannula with the patient in supine position and both eyes open.

The patients presenting with significant vitreous hemorrhage precluding retinal view, with or without retinal detachment (RD), were taken up for 23-gauge pars plana vitrectomy (PPV) within one week of presentation. Posterior vitreous detachment (PVD) induction with the help of intravitreal triamcinolone acetonide and internal limiting membrane (ILM) peeling was done in all the cases. The type of tamponade, 20% sulphur hexafluoride (SF₆) or 1000 centistokes silicon oil (SO), was decided depending upon the intra-operative findings. The patients presenting with no or minimal VH and visible retinal breaks were immediately treated with either laser photocoagulation or cryotherapy.

The patients were divided into three groups. Group 1 included the patients who presented with a clear media with no RD; group 2 included the patients who presented with VH without RD; while group 3

included the patients who presented with RD with or without VH. The patients lost to follow-up were excluded from the study (Fig. 1).

Data analysis

Statistical analysis was performed with STATA statistical software, Version 11.1 (StataCorp, College Station, Texas, USA). Continuous variables were expressed as mean (\pm standard deviation) and categorical variables were expressed as percentages. Comparison between categorical data was performed with Chi-square/ Fisher exact test while difference in continuous data was measured with Student t-test/ Mann-Whitney test. One-way analysis of variance was applied to compare continuous variables in each group over time. Regression analysis was performed to find the effect of patient variables on the change in pressure measurements during the procedure. A two-tailed P value less than 0.05 was considered to be statistically significant.

Results

Using the electronic medical record, we could find 26 patients with globe perforations. However, one patient who was referred from outside refused treatment. Twenty-five patients (25 eyes) received treatment, out of which 13 were males and 12 were females. The mean age was 59.2 ± 11.0 years (Range, 36–72 years). While 10 patients were referred from outside, 15 were in-house complications (Fig. 1). The incidence of in-house globe perforation was 0.002% ($n = 15/595052$). There have been no such inadvertent incidents after shifting to subtenon anaesthesia.

The ocular surgery which the patients were about to undergo included cataract surgery ($n = 23$), silicon oil removal (SOR) with drainage implant ($n = 1$) and penetrating keratoplasty (PKP, $n = 1$). The mean axial length (AL) was 24.7 ± 2.7 mm (Range, 20.9-31.2mm). Eleven eyes (45.8%) had $AL \geq 24$ mm and six (24.0%) had $AL \geq 26$ mm.

The inadvertent scleral perforation was recognised intra-operatively in 9 eyes (36.0%), out of which the planned surgery was postponed in 2 patients and continued in the rest. An inadvertent perforation was suspected on post-operative day 1 (POD-1), POD-30 and POD-120 in 14 (56.0%), 1 (4.0%) and 1 (4.0%) patient respectively. No intra-operative complications were noted in any of the patients with inadvertent perforation. Among the fifteen in-house perforations, the scleral perforation was recognised/ suspected intra-operatively and on POD-1 in eight and six patients respectively. One patient who underwent PKP was suspected to have scleral perforation only after one month. The patient presenting after 4 months was referred from outside.

The most common presenting features were VH ($n = 14$, 56.0%), ocular hypotony ($n = 7$, 28.0%), RD ($n = 7$, 28.0%) and hyphaema ($n = 2$, 8.0%). The treatment included laser photocoagulation or cryotherapy for the retinal break(s) ($n = 7$, 28.0%) and PPV ($n = 17$, 68.0%). One patient who was referred from outside after the suspected perforation, which was recognised immediately and cataract surgery was aborted, presented to our hospital after 3 months. He had a dense cataract and total RD on B-scan. While he

underwent cataract surgery, vitrectomy was avoided in view of advanced proliferative vitreoretinopathy (PVR) changes and poor visual prognosis.

The patients undergoing vitrectomy were operated within the first week except for two patients. The reason for delayed surgery was late referral from outside in one patient and late diagnosis in the other in-house patient due to PKP. Retinal breaks were identified in all the patients. A total of 37 breaks were recognised with 3 breaks noted in two patients and 2 breaks in eight patients (Fig. 2–4). Other complications recognised as the media cleared after vitrectomy included full-thickness macular hole (FTMH, n = 5, 20%), subretinal haemorrhage (SRH, n = 4, 16.0%), retinal necrosis (n = 3, 12%), central retinal artery occlusion (CRAO, n = 2, 8.0%), branch retinal artery occlusion (BRAO, n = 1, 4.0%) and central retinal vein occlusion (CRVO, n = 1, 4.0%). No case of endophthalmitis was noted.

Group 1 included eight patients (32.0%). The mean presenting BCVA was logMAR 0.79 ± 0.73 (Snellen equivalent, 20/123). One patient who had undergone vitrectomy for RRD and was planned for SOR had an inadvertent perforation. He underwent an uncomplicated surgery along with endolaser to the perforation site. Other patients underwent laser photocoagulation. The mean final BCVA was logMAR 0.59 ± 0.79 (Snellen equivalent, 20/78). One patient presented with CRAO and had finger counting vision (Table 1).

Table 1
Demographic and clinical feature of the patients who presented with a clear media (Group 1)

S. No	Age/ Sex	Initial BCVA	AL	Complications	Management	Anatomical outcome	Final BCVA
13	65/M	20/20	24.15	Retinal break, hypotony	Laser photocoagulation	Attached retina	20/20
16	47/F	20/60	23.56	Retinal break, hypotony	Laser photocoagulation	Attached retina	20/60
17	65/F	20/200	23.09	Retinal break, hypotony	Laser photocoagulation	Attached retina	20/80
19	49/M	20/300	23.89	Retinal break, hypotony	Laser photocoagulation*	Attached retina	20/80
20	60/M	20/120	23.84	Retinal break, hypotony	Laser photocoagulation	Attached retina	20/40
21	58/F	20/40	23.24	Retinal break, hypotony	Laser photocoagulation	Attached retina	20/20
24	70/M	FC	22.93	Retinal break, CRAO	Laser photocoagulation	Attached retina	FC
25	47/F	20/60	23.47	Retinal break, hypotony	Laser photocoagulation	Attached retina	20/60

(BCVA: Best-corrected visual acuity; AL: Axial length; *: Planned for silicon oil removal with drainage implant - underwent additional endolaser; FC: Finger counting; CRAO: Central retinal artery occlusion)

Group 2 included ten patients (40.0%). The mean presenting BCVA was logMAR 1.82 ± 0.78 (Snellen equivalent, 20/1321). All patients underwent vitrectomy with SO tamponade in eight patients and SF6 gas tamponade in two patients. The other associated complications in this group included FTMH (n = 2), SRH (n = 2), CRVO (n = 1) and macular pucker with break around the supero-temporal arcade (n = 1). All patients underwent SOR and had an attached retina till the last follow-up. The mean final BCVA was logMAR 0.61 ± 0.20 (Snellen equivalent, 20/81) (Table 2).

Table 2

Demographic and clinical feature of the patients who presented with vitreous haemorrhage but no retinal detachment (Group 2)

S. No	Age/ Sex	Initial BCVA	AL	Complications	Management	Anatomical outcome	Final BCVA
1	65/M	HM	23.8	Retinal break	Vitrectomy, endolaser, SO	Attached retina	20/60
2	80/M	PL+	24.06	Retinal break, SRH	Vitrectomy, endolaser, SO	Attached retina	20/120
4	60/M	20/400	21.5	Retinal break, SRH	Vitrectomy, endolaser, SO	Attached retina	20/120
6	55/M	20/200	29.37	Retinal break	Vitrectomy, endolaser, SO	Attached retina	20/40
7	60/F	FC	29.04	Retinal break, FTMH	Vitrectomy, endolaser, SO	Attached retina	20/120
8	65/F	20/1200	23.68	Retinal break, FTMH	Vitrectomy, endolaser, SO	Attached retina	20/120
9	55/M	PL+	21.54	Retinal break, CRVO	Vitrectomy, endolaser, SO	Attached retina	20/80
14	50/M	20/1200	20.9	Retinal break, macular pucker	Vitrectomy, endolaser, SO	Attached retina	20/120
15	75/M	20/2400	22.96	Retinal break	Vitrectomy, endolaser, SF6	Attached retina	20/40
23	71/F	20/800	22.77	Retinal break	Vitrectomy, endolaser, SF6	Attached retina	20/60
(BCVA: Best-corrected visual acuity; AL: Axial length; HM, Hand movement; SO: Silicon oil; PL: Perception of light; SRH: Subretinal haemorrhage; FC: Finger counting; FTMH: Full-thickness macular hole; CRVO: Central retinal vein occlusion SF6: Sulphur hexafluoride)							

Group 3 included seven patients (28.0%). The mean presenting BCVA was logMAR 2.13 ± 0.59 (Snellen equivalent, 20/2698). All the patients underwent vitrectomy with SO tamponade except for one patient who presented with advanced PVR changes and poor visual prognosis. The other complications included VH (n = 5), SRH (n = 2), BRAO (n = 1) and CRAO (n = 1). All patients underwent SOR and had an attached

retina till the last follow-up. The mean final BCVA was logMAR 1.25 ± 0.64 (Snellen equivalent, 20/356). Two patients had a final BCVA $\leq 20/1200$ due to CRAO and failed PKP graft respectively (Table 3).

Table 3
Demographic and clinical feature of the patients presented with retinal detachment with or without vitreous haemorrhage (Group 3)

S. No	Age/ Sex	Initial BCVA	AL	Complications	Management	Anatomical outcome	Final BCVA
3	60/F	HM	25.77	VH, Retinal break, SRH, FTMH	Vitrectomy, endolaser, SO	Attached retina	20/1200
5	55/F	PL+	26.89	VH, Retinal break, SRH, FTMH	Vitrectomy, endolaser, SO	Attached retina	20/120
10	72/F	20/400	24.3	VH, Retinal break, IT-BRAO	Vitrectomy, endolaser, SO	Attached retina	20/120
11	42/M	20/200	31.22	VH, Retinal break, hypotony	Vitrectomy, endolaser, SO	Attached retina	20/120
12	46/M	FC	29.59	VH, Retinal break, FTMH	Vitrectomy, endolaser, SO	Attached retina	20/240
18	36/F	20/1200	24.18	Retinal break	Vitrectomy, endolaser, SO	Attached retina	FC
22	71/F	PL+	26.89	Retinal break	nil*	RD	PL+

(BCVA: Best-corrected visual acuity; AL: Axial length; HM, Hand movement; VH: Vitreous haemorrhage; SRH: Subretinal haemorrhage; FTMH: Full-thickness macular hole; SO: Silicon oil; PL: Perception of light; IT-BRAO: Infero-temporal branch retinal artery occlusion; FC: Finger counting; *: vitrectomy avoided in view of advanced proliferative vitreoretinopathy changes and poor visual prognosis; RD: retinal detachment)

Table 4

Review of the previous studies highlighting the management of inadvertent needle perforation during ocular local anaesthesia (minimum 10 cases)

Author	Type of injection	RD	Management		Outcome	
			Surgery	Laser/ Cryopexy	Anatomical	Visual
Grizzard <i>et al</i> (1991) ¹⁶	Retro (5) Peri (4) NA (3)	5/12	5	5	Attached - 9 (75.0%) Detached - 2 Peripheral detachment - 1	≥ 20/40: 7 20/50 - 20/200: 0 19/200- 3/200: 1 ≤FC: 4
Duker <i>et al</i> (1991) ¹⁹	Retro (18) Peri (2)	11/20	16	0	Attached - 15 Detached - 5	≥ 20/40: 3 20/50 - 20/200: 3 19/200- 3/200: 1 ≤FC: 13
Hay <i>et al</i> (1991) ¹⁸	Retro (12) Peri (11)	14/23	13	5	Attached - 19 Detached - 4	≥ 20/40: 6 20/50 - 20/200: 3 19/200- 3/200: 3 ≤FC: 11
Rinkoff <i>et al</i> (1991) ¹⁰	Retro (11) NA (1)	3/12	6	5	Attached - 10 Detached - 2	≥ 20/40: 3 20/50 - 20/200: 6 19/200- 3/200: 2 ≤FC: 1
McCombe <i>et al</i> (1993) ⁶	Retro (9) Peri (2) NA (2)	4/13	9	NA	Attached - 12 Detached - 1	≥ 20/40: 6 20/60 - 20/80: 4 ≤FC: 11

(RD: Retinal detachment; Retro: Retroocular; Peri: Peribulbar; NA: Not available; FC: Finger counting; Subconj: Subconjunctival)

Author	Type of injection	RD	Management	Outcome	
Wearne <i>et al</i> (1998) ¹⁷	Retro (14) Peri (4) NA (2)	10/20	17	1	Attached - 11 Detached - 9 ≥ 20/40: 7 20/50 - 20/200: 5 19/200- 3/200: 0 ≤FC: 8
Gadkari <i>et al</i> (2007) ¹⁴	Retro (6) Peri (10) Subconj (3)	8/19	14	4	Attached - 18 Detached - 1 ≥ 20/40: 7 20/50 - 20/200: 7 19/200- 3/200: 2 ≤FC: 3
(RD: Retinal detachment; Retro: Retroocular; Peri: Peribulbar; NA: Not available; FC: Finger counting; Subconj: Subconjunctival)					

Discussion

Scleral perforation is a rare but one of the most devastating complications of local ocular anesthesia.¹⁻³¹ Studies have suggested an incidence of 0.007-0.13%, with the rate being higher for retrobulbar blocks than peribulbar.^{1,2,6,9,12,14,21} The incidence of globe perforation at our center was similar to that reported in literature. The risk factors for this unfortunate incident include posterior staphyloma, long axial length, uncooperative patient, multiple attempts and inexperienced personnel.^{4-6,8,12-15,18,19} A combination of these factors was responsible for globe perforation in our series.

The early indicators of globe perforation include movement of eyeball while moving the anesthetic needle, unusual difficulty while injecting, severe pain response, sudden increase in the intraocular pressure or severe hypotony, corneal clouding, change in the ocular red reflex, sudden loss of vision, visible enlargement of the eyeball, and popping sound.^{9-11,14,21} However, it is not always easy to identify the perforation at the time of injecting. In our case series, only half patients were identified to have perforations. Other authors have also reported that most perforations are recognized in the post-operative period.^{3,4,7,10,15,17,18}

The early management remains controversial. While some authors advocate postponing the planned surgery, others recommend proceeding with the same. In case the cataract is dense, it is better to proceed with the surgery. No contraindication for the placement of an intraocular lens has yet been reported.^{6,10,15-17,19} In our case series, all but one patient underwent the surgery immediately without any intra-operative complications. A vitreoretinal opinion should be sought as early as perforation is suspected. In

case of a clear media, treatment of the site of perforation leads to a good outcome. None of such patients in our case series progressed to RD. This may be due to a pre-existing posterior vitreous detachment or scar formation subsequent to the local inflammatory reaction produced around the site of the tear.^{6,9,10,15} It is imperative to mention that these patients need to be followed-up closely as subretinal fluid can accumulate rapidly.

The presence of VH with or without RD warrants an immediate vitrectomy due to aggressive development of PVR changes.^{4, 6-10,14, 15-17,19,21} One patient in our series, who presented 4 months after the perforation had such advanced PVR that surgery could not be performed. An early surgery in the other patients helped achieve cent percent anatomical success. The retina remained attached even after tamponade was removed. The outcome of patients in our case series were better than reported earlier.^{6,10,14,16-19} This may be due to early recognition and timely management as well as improvement in the technique of vitreoretinal surgery over the years. Table 4 summarises the results of the previous studies reporting the management outcomes of ocular perforation during local ocular anaesthesia.

More than half the patients achieved BCVA \geq 20/80. As reported in the literature, the patients with RD in our series also had a worse visual outcome than those without RD.^{6,18,19} One-fourth patients achieved a final BCVA $<$ 20/200. The causes for poor visual outcome in these cases included vascular occlusion (n = 3), retinal necrosis inside the macula (n = 1), RD with advanced PVR changes (n = 1) and failed PKP graft (n = 1). Retinal vascular occlusions may be caused by inadvertent injection of the medication into the globe leading to a sudden rise of intraocular pressure, popularly called as ocular explosion.^{11,17} Even in case of scleral perforation, utmost care should be taken to prevent injecting the anaesthetic agent intraocularly as it can lead to mechanical as well as chemical damage. One-fourth patients achieved a final BCVA 20/120 – 20/200. The causes for sub-optimal gain in vision in these patients included macular pathologies like FTMH, SRH and macular pucker. Other authors have also reported poor visual outcome due to macular injury during the anaesthesia.^{4,9,18,21,28-30}

To the best of our knowledge, this is the largest case series till date evaluating the management of inadvertent scleral perforation during peribulbar anesthesia. The limitations of the study include its retrospective nature and small sample size.

In conclusion, it is important to be extremely cautious while giving peribulbar anesthesia in high-risk cases or shift to safer techniques like subtenon anesthesia. Ocular perforation should be suspected when fresh VH is noted on the first POD. Early appropriate intervention for associated complications can help achieve a good outcome to the patients with inadvertent perforation. Risk factors for poor outcome include intraocular injection of the anesthetic drugs, macular injury and RD.

Declarations

Compliance with Ethical Standards:

Funding: This study was not funded by anyone

Conflict of Interest: All authors certify that they have no conflict of interests.

(Humans were involved in study) Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

(Humans were involved in study) Informed consent: Informed consent was obtained from all individual participants included in the study.

(Animals were not involved) Ethical approval: This article does not contain any studies with animals performed by any of the authors.

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Figures

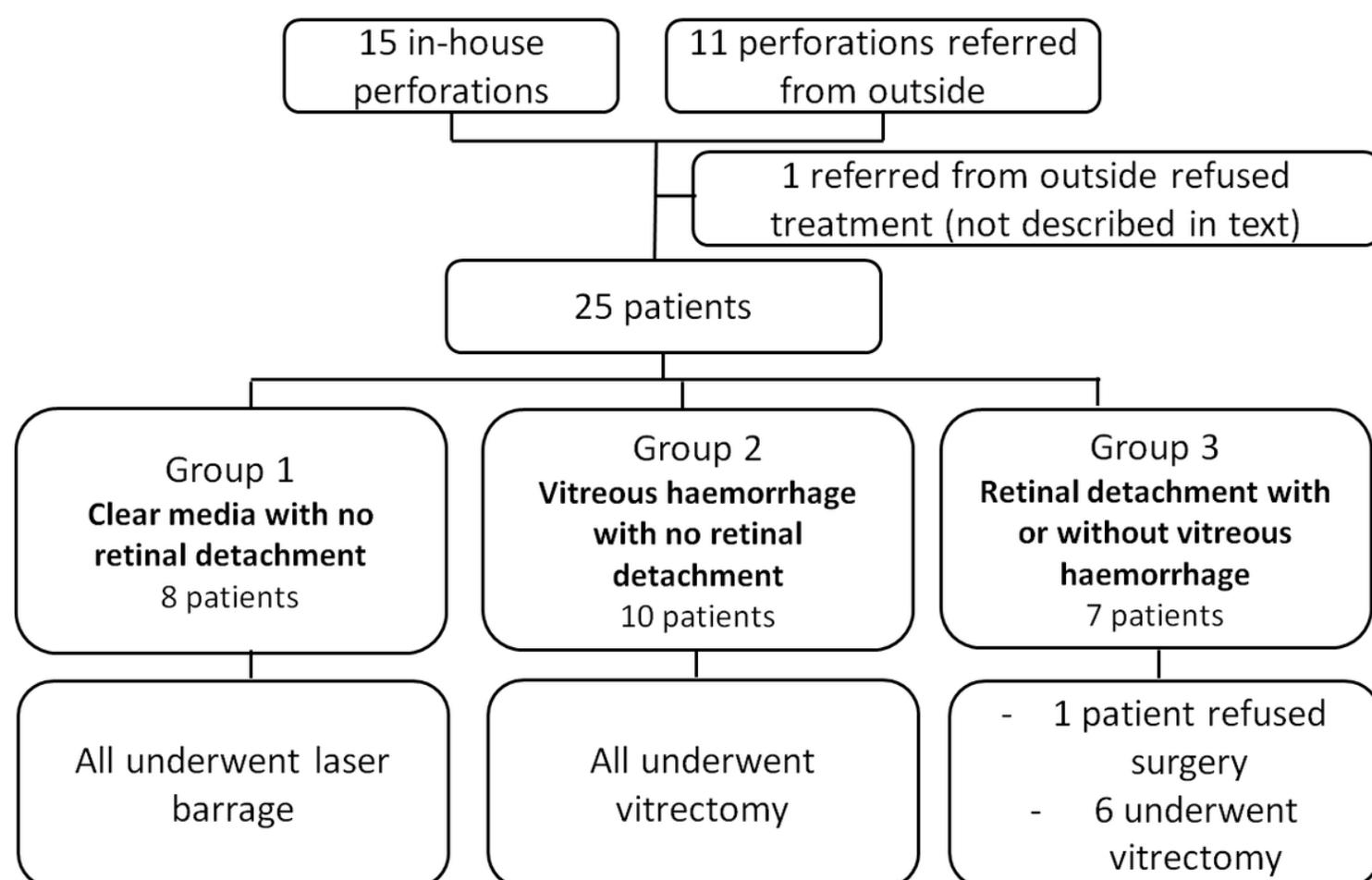


Figure 1

Flowchart representing the number of patients treated for inadvertent ocular perforation during peribulbar anaesthesia.

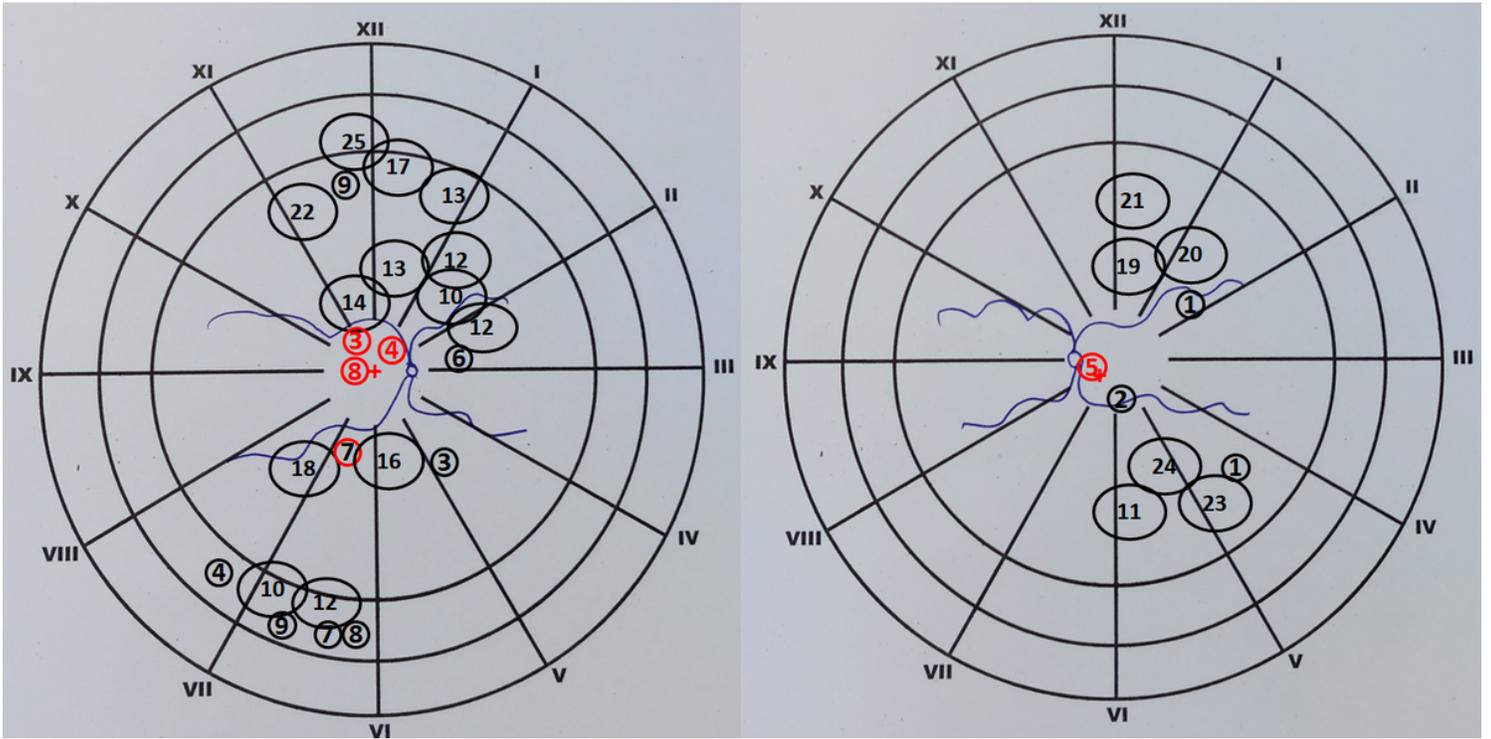


Figure 2

Bjerrum chart showing the location of all the perforation sites in each patient in their respective a) right eye; and b) left eye (black circle - entry wound, red circle - exit wound).

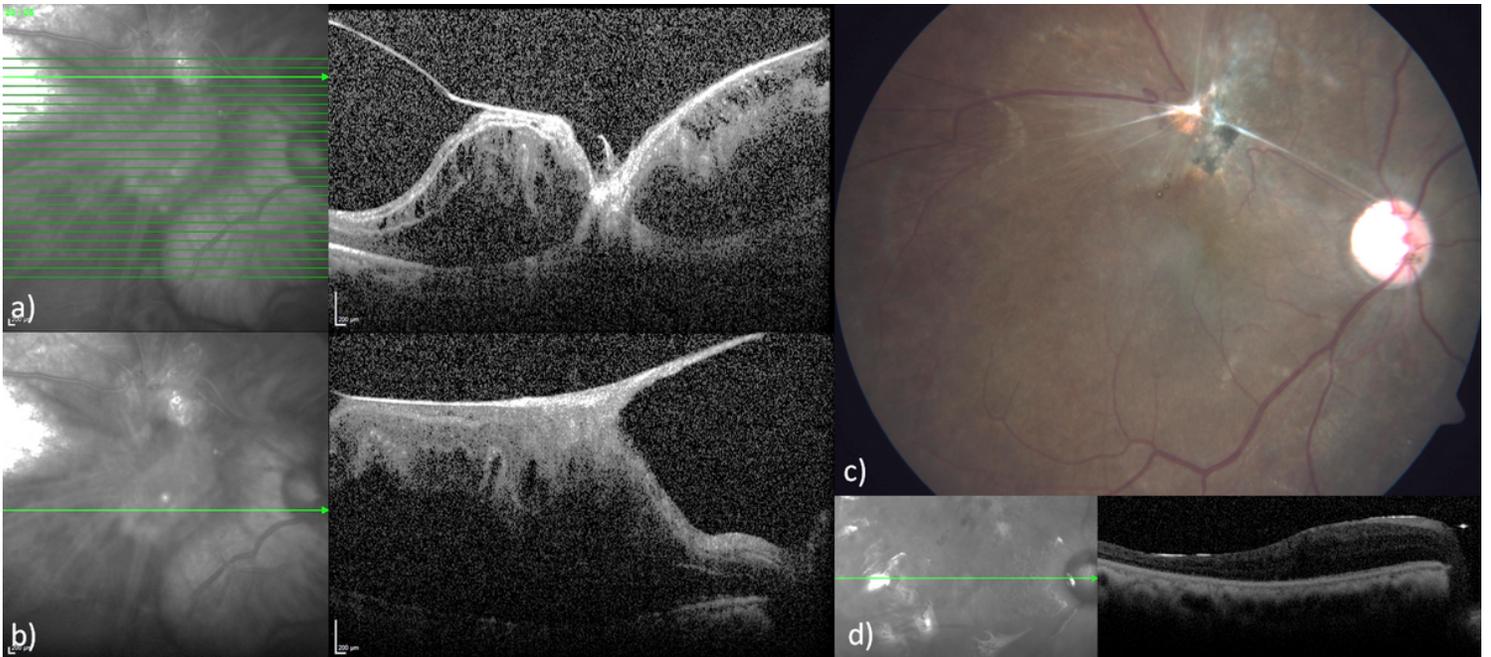


Figure 3

Images of patient number 14. a,b) Optical coherence tomography (OCT) line scans at presentation through the (a) site of perforation and (b) fovea showing macular pucker; c) fundus image taken after

silicon oil removal showing the site of perforation with a healthy macula and d) OCT line scan after vitrectomy with silicon oil tamponade showing a settled macula with no epiretinal membrane.

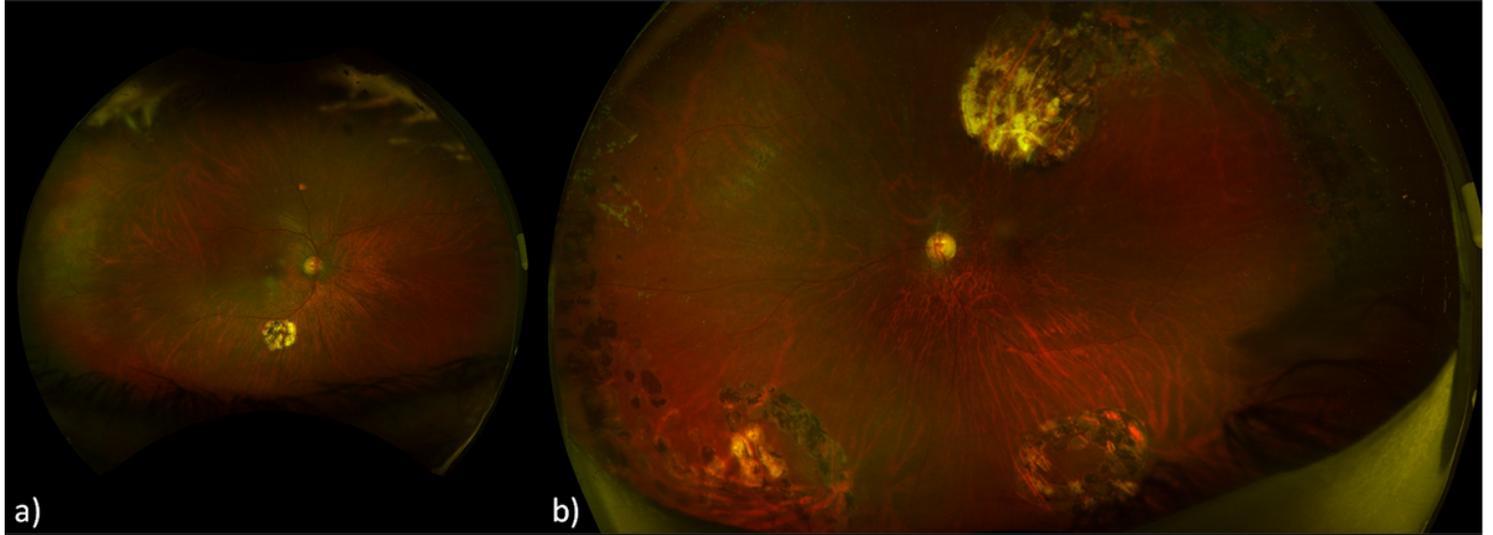


Figure 4

Ultrawide field images (Optomap) taken after silicon oil removal of a) patient number 15 showing lasered site of perforation in the infero-temporal quadrant; and b) patient number 19 showing lasered breaks in the inferior half (original retinal detachment surgery) and lasered site of perforation in the supero-temporal quadrant. Patient number 19 had inadvertent perforation at the time of silicon oil removal.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [data.xlsx](#)