Nd:YAG laser treatment for premacular subhyaloid haemorrhage

C.A. RENNIE, D.K. NEWMAN, M.P. SNEAD, D.W. FLANAGAN

CLINICAL STUDY

Abstract

Purpose **Premacular subhyaloid haemorrhage produces sudden, profound visual loss which may be prolonged if untreated. Nd:YAG laser treatment can create a posterior hyaloidotomy enabling rapid diffusion of subhyaloid haemorrhage into the vitreous gel. This study was performed to assess the results of Nd:YAG laser hyaloidotomy and to compare the outcome with similar conservatively managed cases.**

Methods **Nd:YAG laser hyaloidotomy was performed in 6 patients with premacular subhyaloid haemorrhage. The aetiologies were Valsalva retinopathy, macroaneurysm, branch retinal vein occlusion, proliferative diabetic retinopathy (2 cases) and idiopathic. Four patients with premacular subhyaloid haemorrhage were managed conservatively. The aetiologies were Valsalva retinopathy (2 cases), macroaneurysm and proliferative diabetic retinopathy.**

Results **Nd:YAG laser hyaloidotomy achieved rapid resolution of subhyaloid haemorrhage in all treated patients. Visual acuity improved to 6/9 or better in 4 patients, but was limited by ischaemic diabetic retinopathy in 2 patients. No patient had evidence of damage to the retina or choroid from treatment. Among the conservatively managed cases, 3 patients had slow resolution of the subhyaloid haemorrhage over 3–6 months. One patient with diabetic retinopathy demonstrated little improvement at 18 months.**

Conclusion **Nd:YAG laser hyaloidotomy is a safe and effective procedure. It achieves rapid resolution of premacular subhyaloid haemorrhage with restoration of visual function, preventing the need for vitreoretinal surgery.**

Key words Diabetic retinopathy; Laser surgery; Proliferative vitreoretinopathy; Retinal disease; Retinal haemorrhage; Vitreous haemorrhage

Premacular subhyaloid haemorrhage produces sudden profound visual loss which may be prolonged if untreated. It results from a variety of disorders including Valsalva retinopathy, macroaneurysms, retinal vein occlusions and diabetic retinopathy.[1] It may also be complicated by epiretinal membrane formation or tractional retinal detachment in diabetic retinopathy and macroaneurysms.[2,3]

This condition has previously been treated by vitrectomy or managed conservatively with slow resolution over several months.[2,4] Nd:YAG laser treatment can be used to produce a defect in the posterior hyaloid membrane.[5] This allows rapid diffusion of the haemorrhage from the subhyaloid space into the vitreous gel allowing gravitation away from the visual axis. This study was undertaken to assess the results of Nd:YAG laser posterior hyaloidotomy in a series of patients with premacular haemorrhage of differing aetiologies and to compare the outcome of similar cases that were managed conservatively.

Methods

Six patients with premacular subhyaloid haemorrhage were treated by Nd:YAG laser hyaloidotomy. The Zeiss Visulag system Nd:YAG laser was used. Full pupillary dilatation was achieved with g. cyclopentolate 1% and g. phenylephrine 10%. A Goldmann fundus contact lens was used to allow focusing of the Nd:YAG aiming beam and laser. An opening was made in the posterior hyaloid membrane at the inferior edge of the subhyaloid haemorrhage, at a location distant from the fovea and retinal blood vessels but with a sufficient thickness of blood to protect the underlying retina. The power required varied from 4.2 mJ up to 9.2 mJ if necessary to achieve an opening in the posterior hyaloid membrane.

Results

Patients treated by Nd:YAG laser hyaloidotomy

Nd:YAG laser hyaloidotomy achieved rapid resolution of premacular subhyaloid haemorrhage in all 6 treated patients (Table 1, Fig. 1). There was an immediate stream of red blood cells into the vitreous gel following laser treatment in 5 cases. In 1 case, the subhyaloid

C.A. Rennie
D.K. Newman
M.P. Snead
D.W. Flanagan
Department of Ophthalmology
Addenbrooke's Hospital
Cambridge CB2 2QQ, UK

Mr D. Flanagan ✉
Department of Ophthalmology
Addenbrooke's Hospital
Hills Road
Cambridge CB2 2QQ, UK
Tel: +44 (0)1223 216106
Fax: +44 (0)1223 217968
e-mail: declan.flanagan@breathemail.net

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Table 1. *Visual outcome in patients who received Nd:YAG laser treatment*

Patient no.	Aetiology	Other features	Presenting VA	Time to treatment	Post-treatment VA (at 1–2 weeks)	Final VA	Follow-up (months)
1	Idiopathic	None	PL	3 weeks	6/9	6/6	27
2	Valsalva retinopathy	None	2/60	10 days	6/9	6/6	7
3	Macroaneurysm	Subretinal haemorrhage	4/60	1 week	6/9	6/9	7
4	Branch vein occlusion	Fellow eye amblyopic	4/60	1 month	6/12	6/9	7
5	Proliferative diabetic retinopathy	Diabetic maculopathy	CF	1 month	6/60	6/24[a]	31
6	Proliferative diabetic retinopathy	Diabetic maculpathy/ CRVO in fellow eye	6/60	2 days	6/24	6/36[a]	7

VA, visual acuity; CRVO, central retinal vein occlusion.
[a]Final visual acuity limited by ischaemic diabetic maculopathy.

haemorrhage was immobile immediately after the hyaloidotomy but diffused into the vitreous gel over the following week. The following case reports describe the clinical features of these patients.

Case 1

A 47-year-old man presented with sudden deterioration of vision in the left eye. His visual acuity was reduced to perception of light due to a large premacular subhyaloid haemorrhage. There was no identifiable aetiology for the subhyaloid haemorrhage. A Nd:YAG laser hyaloidotomy was performed at 3 weeks. There was little change immediately after treatment, but the haemorrhage slowly cleared over the following week. Visual acuity improved to 6/9 initially, and to 6/6 by 2 months with a normal fundus; there were no further changes during 2 years of follow-up.

Case 2

A 23-year-old man presented with loss of vision in his left eye following a road traffic accident in which he sustained a fractured tibia. Visual acuity was reduced to 2/60 due to a premacular subhyaloid haemorrhage. The presumed aetiology was a Valsalva manoeuvre at the time of injury. A Nd:YAG laser hyaloidotomy was performed 10 days later. Visual acuity improved to 6/9 after 1 week with a diffuse intragel haemorrhage. After 3 weeks, the subhyaloid haemorrhage had completely cleared with visual acuity of 6/6. The intragel haemorrhage had cleared by 7 months and the vision remained at 6/6.

Case 3

A 70-year-old woman with hypertension and cerebrovascular disease presented with a sudden loss of vision in her left eye. Visual acuity was reduced to 4/60 by a premacular subhyaloid haemorrhage resulting from a ruptured macroaneurysm. A Nd:YAG laser hyaloidotomy was performed 1 week later. Visual acuity improved to 6/36 after 1 week and 6/9 after 2 weeks. The subhyaloid haemorrhage cleared to reveal an associated subretinal haemorrhage. There were no further changes and the acuity remained stable during 7 months of follow-up.

Case 4

A 70-year-old woman presented with a sudden loss of vision in her right eye. Visual acuity was reduced to 4/60 due to a premacular subhyaloid haemorrhage. The aetiology was an old ischaemic branch retinal vein occlusion with preretinal neovascularisation along the superior temporal arcade vessels. She had not previously received laser treatment. The vision in the left eye was also reduced due to amblyopia, with an acuity of 6/36. A Nd:YAG laser hyaloidotomy was performed 1 month later because the subhyaloid haemorrhage had failed to clear. Visual acuity improved to 6/12 within 2 weeks with a small area of residual haemorrhage that had gravitated inferiorly. After 7 months the visual acuity was 6/9 with no further changes.

Case 5

A 67-year-old woman with proliferative diabetic retinopathy presented with sudden loss of vision in her left eye. Visual acuity was reduced to counting fingers due a premacular subhyaloid haemorrhage. She had previously undergone bilateral focal macular laser treatment and panretinal photocoagulation, and left cataract surgery. Visual acuity in her right eye was reduced to hand movements due to exudative maculopathy. A Nd:YAG laser hyaloidotomy was performed 1 month later when there had been no improvement. One week after treatment, the subhyaloid haemorrhage had cleared to reveal optic disc neovascularisation and macular oedema. This was treated by panretinal photocoagulation. Visual acuity eventually improved to 6/24 after 31 months, but was limited by ischaemic maculopathy.

Case 6

A 75-year-old man with adult-onset diabetes mellitus, chronic renal failure, vascular disease and diabetic retinopathy, presented with sudden loss of vision in his

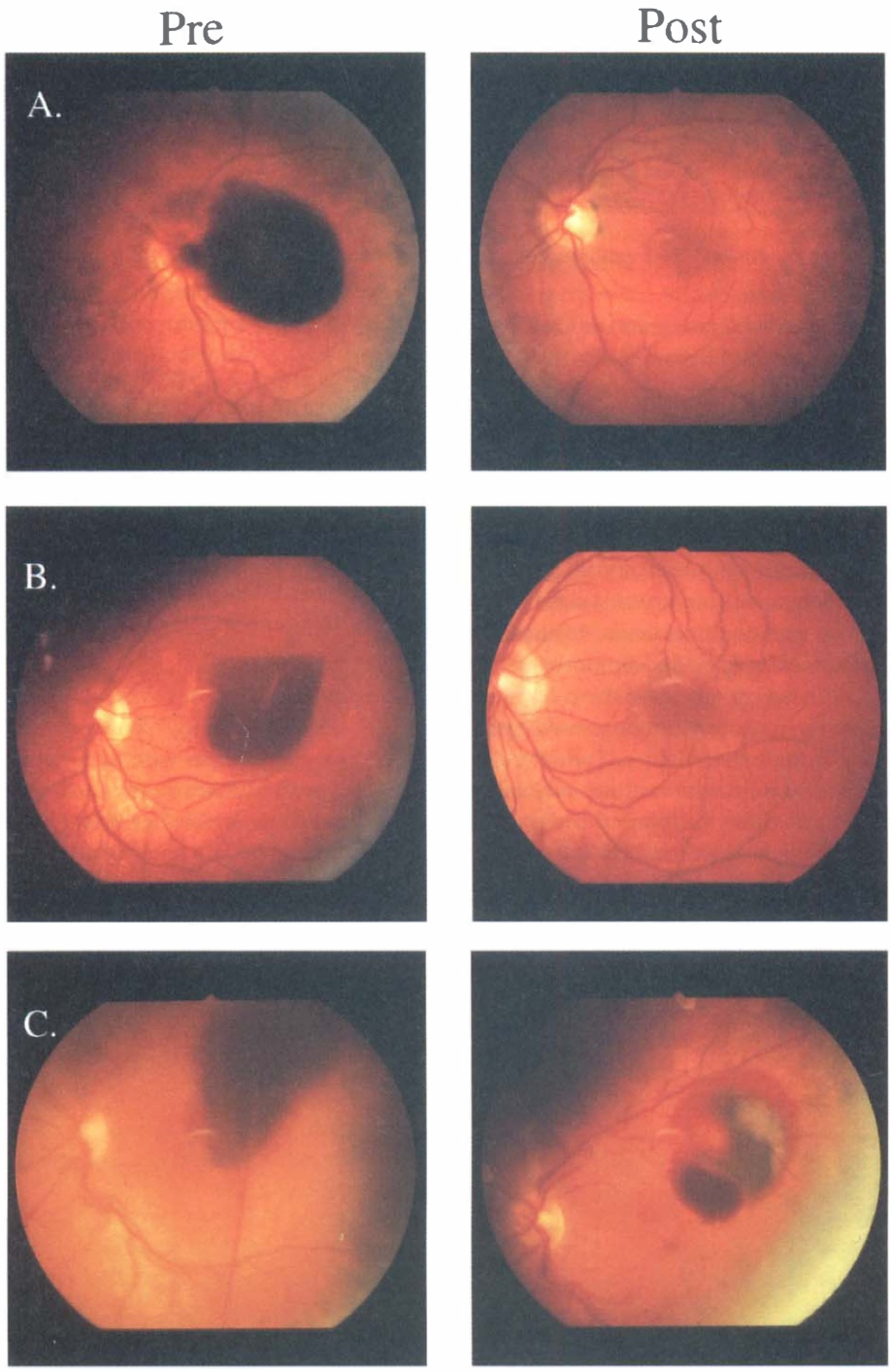

Fig. 1. *Pre- and post-treatment photographs from patients 1 (A), 2 (B) and 3 (C). (C) shows rapid dispersion of haemorrhage into the vitreous gel immediately after performing the Nd:YAG hyaloidotomy.*

left eye. Visual acuity was reduced to 6/60 due to a premacular subhyaloid haemorrhage resulting from proliferative diabetic retinopathy. This eye also had chronic open angle glaucoma and treated diabetic maculopathy. The visual acuity in the right eye was reduced to counting fingers by a previous central retinal vein occlusion. A Nd:YAG laser hyaloidotomy was performed 2 days later. Visual acuity improved to 6/24 after 1 week, revealing preretinal neovascularistion along the superotemporal arcade. At 1 month the vision had improved further to 6/12. Over the following 6 months the patient developed increasing retinal ischaemia with severe macular oedema reducing the vision to 6/36, which was treated by macular grid photocoagulation followed by panretinal photocoagulation. The laser hyaloidotomy allowed early assessment of the macula and rapid visual rehabilitation in a patient who was not medically fit for an invasive procedure.

Conservatively managed patients

Four patients with premacular subhyaloid haemorrhage were observed (Table 2, Fig. 2). Three patients had slow resolution of the haemorrhage over 3–6 months. One

Table 2. *Visual outcome in patients who were managed conservatively*

Patient no.	Aetiology	Other features	Presenting VA	Final VA	Follow-up (months)
1	Valsalva retinopathy	None	6/60	6/9	4
2	Valsalva retinopathy	None	6/60	6/12	12
3	Macroaneurysm	Subfoveal haemorrhage	CF	6/18	5
4	Proliferative diabetic retinopathy	None	6/12[a]	6/9	18

VA, visual acuity.
[a]The subhyaloid haemorrhage covered the inferior macular region but spared the fovea.

patient with proliferative diabetic retinopathy had little improvement in the subhyaloid haemorrhage at 18 months. The following case reports describe the clinical features of these patients.

Case 1

A 15-year-old boy presented with loss of vision in his right eye following a minor head injury sustained whilst playing football. There was no direct ocular trauma. Visual acuity was reduced to 6/60 and fundoscopy revealed a subhyaloid haemorrhage over the central and inferior macula. This was presumed to be caused by a Valsalva manoeuvre at the time of injury. Two months later, his visual acuity was 6/18 with residual subhyaloid haemorrhage. Four months after the injury the vision had improved to 6/9 with only a faint residual line of subhyaloid haemorrhage present in the inferior macula.

Case 2

A 35-year-old man presented with a central scotoma in his left eye after a road traffic accident which resulted in a minor head injury and bruising to the ribs. Visual acuity was reduced to 6/60 with two large subhyaloid haemorrhages covering the superior and inferior macula. The presumed aetiology was a Valsalva manoeuvre. The haemorrhage slowly cleared with gradual visual improvement. His visual acuity was 6/24 at 2 months and 6/12 after 6 months and on review 1 year later.

Case 3

A 65-year-old woman with hypertension and cerebrovascular disease presented with a sudden loss of vision in her right eye. Her visual acuity was reduced to counting fingers by a subhyaloid haemorrhage arising from a ruptured macroaneurysm in the superior macula.

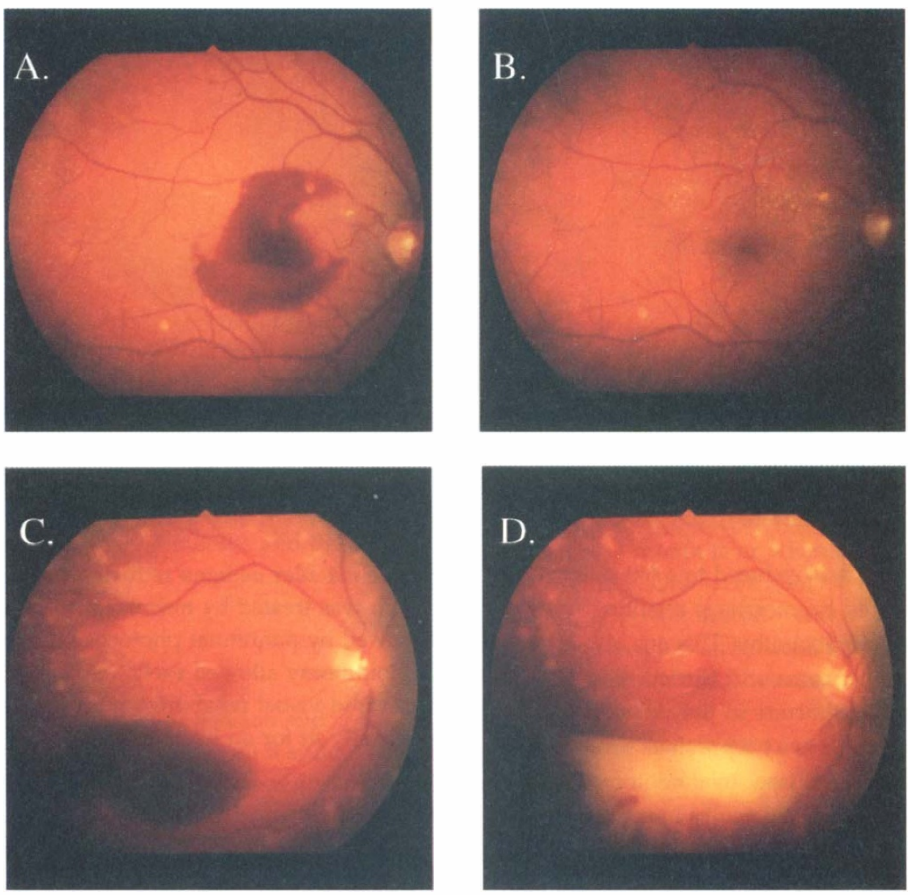

Fig. 2. *Illustrative cases of conservatively managed patients. The initial subhyaloid haemorrhage (A) in patient 3 and after spontaneous resolution at 5 months (B). The initial subhyaloid haemorrhage (C) in patient 4 which evolved into white altered haemorrhage after 18 months of follow-up (D).*

The subhyaloid haemorrhage slowly improved to reveal an associated subfoveal haemorrhage at 2 weeks. By 3 months the subhyaloid haemorrhage had resolved to reveal retinal exudates and mild macular oedema. This changed little over the following 2 months and her visual acuity did not improve beyond 6/18.

Case 4

A 36-year-old man received bilateral panretinal photocoagulation for early proliferative diabetic retinopathy but was lost to follow-up for 4 years. He then presented with a subhyaloid haemorrhage covering the inferior macula of his right eye. Visual acuity was 6/12 with sparing of the fovea. He was treated with fill-in panretinal photocoagulation, but the subhyaloid haemorrhage was managed conservatively because it did not involve the central macula. The subhyaloid haemorrhage failed to resolve after 2 years of follow-up but evolved into a collection of white altered blood; the visual acuity was 6/9.

Discussion

Nd:YAG laser hyaloidotomy achieved rapid resolution of premacular subhyaloid haemorrhage in all 6 cases treated in this study, without any clinical evidence of damage to the underlying retina or choroid from treatment. In 4 patients, this resulted in an improvement in vision from 6/60 or worse to 6/12 or better within 2 weeks. The other 2 patients returned to their pre-morbid visual acuity, which was limited by diabetic maculopathy. This study supports the findings of other series where the Nd:YAG laser has been used to achieve rapid clearance of subhyaloid haemorrhage.[5–13]

It can be difficult to achieve accurate focusing of the Nd:YAG laser for hyaloidotomy using an instrument designed for the anterior segment. The aiming and focusing accuracy of the laser is dependent on the convergence angle. The angle of aperture of the YAG laser system is designed for 16 ° in air. Incident light will fall on the iris if there is a disparity between the cross-sectional area of the beam and the size of the pupil itself. This attenuation of the laser beam reduces the power density at the desired target. This can cause the surgeon to increase the power such that if the beam is moved and the full power restored there could be a risk of damage at the retina. In order to avoid these problems it is important to work with the widest possible pupil (at least 6 mm) and to keep the laser beam aimed through the centre of the pupil. It is not always possible for the operator to know whether the fundus is being viewed through the pupil centre when using a lens. Iris clipping can occur without changing the fundus view if the laser beam cross-section is larger than the pupillary area required to obtain a clear view of the fundus.[14,15]

Photomechanical retinal injury can occur with use of the Nd:YAG laser in the posterior segment, resulting in vitreous, intraretinal or subretinal haemorrhage.[14] Experimental studies show that using the Nd:YAG laser to cut vitreous membranes 1.5–3 mm from the retinal surface is associated with injury, most commonly choroidal haemorrhage.[16] In a study of 5 eyes that received accidental Nd:YAG laser injuries to the macula all developed a single full-thickness retinal hole with varying degrees of sub- and preretinal haemorrhages. These injuries occurred in university, non-medical research Nd:YAG lasers which have a much greater power (150–300 mJ) than the ophthalmic Nd:YAG lasers. Also in this setting the lasers probably had a non-converging beam which was then focused on the neurosurgery retina by the optics of the patient's eye. The distance of the hole from the fovea determined the final visual acuity, improving in those cases where the injury was greater than 30 μm from the foveal centre.[17] Clinical examination revealed no evidence of retinal or choroidal haemorrhage, or retinal pigment epithelial changes, from Nd:YAG treatment in any of the patients in this series. In only one paper on the use of the Nd:YAG laser for subhyaloid haemorrhage did 2 of 21 patients develop complications. One developed a macular hole and the other a retinal break in a myopic eye (the fellow untreated eye also developed breaks).[13] Gabel *et al.*[7] speculated that the dense premacular subhyaloid haemorrhage shielded the underlying retina from laser-induced damage, even at higher energies. The site of hyaloidotomy should therefore be chosen away from the fovea and major blood vessels, with some underlying haemorrhage to protect the retina.

The Valsalva manoeuvre produces a sudden rise in venous pressure which can result in rupture of a retinal vein or pre-existing vascular weakness and a subhyaloid haemorrhage (Valsalva retinopathy). This generally clears over several months and has a good visual prognosis because there is rarely associated retinal damage.[18,19] Laser treatment in this condition hastens the visual recovery but needs to be balanced against the theoretical risk of damage to the retina.

Macroaneurysms are acquired dilatations of retinal arterioles that may present with loss of central vision due to macular oedema or rupture with sub-, intra- or preretinal haemorrhage. The visual prognosis is good for preretinal and vitreous haemorrhage but subretinal haemorrhage may result in retinal pigment epithelial disturbance or subretinal scarring with limited visual recovery. Intraretinal haemorrhage does not preclude recovery of visual function.[3,20,21] A series of 6 cases receiving Nd:YAG laser hyaloidotomy for subhyaloid haemorrhage due to macroaneurysms showed prompt resolution of the haemorrhage in all cases but poor visual recovery in 4 patients due to associated subretinal haemorrhage.[10]

Branch retinal vein occlusion may result in premacular subhyaloid haemorrhage associated with preretinal neovascularisation from an area of ischaemia. Nd:YAG laser hyaloidotomy achieves rapid clearance of the subhyaloid haemorrhage enabling early assessment and further treatment of the branch retinal vein occlusion as appropriate.

Premacular subhyaloid haemorrhage occurs in proliferative diabetic retinopathy when a localised posterior vitreous detachment produces traction on

preretinal neovascular tissue with subsequent haemorrhage into the retrohyaloid space.[22] The visual outcome in the patients with proliferative diabetic retinopathy in this series was limited by associated ischaemic maculopathy. In proliferative diabetic retinopathy, untreated subhyaloid haemorrhage clears slowly and neovascular proliferation can lead to a risk of epiretinal membrane formation or tractional retinal detachment.[2] The subhyaloid haemorrhage will also obscure any macular oedema that requires treatment prior to panretinal photocoagulation.[11,23] In a series of 9 eyes with dense premacular haemorrhage and diabetic retinopathy, Nd:YAG laser membranotomy achieved complete intravitreal dispersion of the haemorrhage within 1 week enabling detailed macular assessment before further treatment. This allowed clinically significant macular oedema to be identified and treated prior to panretinal photocoagulation in 3 eyes. The visual acuity stabilised at pre-haemorrhage levels in 7 eyes with no tractional retinal detachment or re-bleeding, and no eye required vitrectomy.[11]

Early vitrectomy has also been advocated for dense premacular haemorrhage due to proliferative diabetic retinopathy. Vitrectomy gives the advantage of removing the haemorrhage and delamination of the membrane that serves as a scaffold for neovascularisation.[2,22,24] Both the treated and observed patients in this series had localised posterior vitreous detachments which remained unchanged after resolution of the subhyaloid haemorrhage. A larger prospective study would be needed to compare the long-term outcome of patients receiving Nd:YAG laser hyaloidotomy or early vitrectomy, and in particular to assess the visual implications of residual vitreoretinal attachments in the non-vitrectomised eye.

Nd:YAG laser hyaloidotomy is shown to be a safe and effective procedure. It produces rapid dispersion of subhyaloid haemorrhage, with restoration of visual function, without a more invasive vitreoretinal procedure. This is particularly important for patients with poor vision in their fellow eye and patients requiring rapid visual rehabilitation to be able to continue working. It also allows early assessment and treatment of the macula in diabetic retinopathy and branch retinal vein occlusion. If untreated, the subhyaloid haemorrhage resolves slowly with prolonged reduction in visual function and possible toxic damage to the retina from prolonged contact with haemoglobin and iron.[2] The final visual prognosis is, however, limited by the underlying cause of the subhyaloid haemorrahge and any associated retinal changes.

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