Saudi Journal of Ophthalmology (2017) 31, 250–256

Review Article

Purtscher-like retinopathy – A rare complication of acute myocardial infarction and a review of the literature

Leslie Jonathan Pek Seng Ang *; Benjamin Chong Ming Chang

Abstract

Purtscher-like retinopathy is an uncommon condition with features similar to Purtscher retinopathy but have non-traumatic causes. Several pathogenic mechanisms have been put forth with differing views on treatment options. We describe for the first time, a case of Purtscher-like retinopathy which developed following a myocardial infarct and a transient ischemic attack. We present a review of the literature on this condition, describing the various clinical presentations, investigation findings, treatment options and prognosis.

Keywords: Purtscher, Purtscher-like retinopathy, Myocardial infarction, Transient ischemic attack

http://dx.doi.org/10.1016/j.sjopt.2017.05.009

Introduction

Purtscher-like retinopathy (PUR) covers a spectrum of conditions with clinical presentation similar to that of Purtscher's retinopathy, but unlike that which was originally described by Purtscher,[1] they have etiologies that are non-traumatic. Many causes have been described, most as single case reports with a few small cases series, and all have been retrospective. Trauma, acute pancreatitis, valsalva maneuver, thrombotic thrombocytopenic purpura, and pregnancy-related causes are among the more commonly described etiologies.[2] We describe here a case of PUR in a patient following a myocardial infarction (MI), who suffered a concomitant transient ischemic attack (TIA), and review the literature on this rare but interesting condition.

Case report

Our patient is a 50 year old man who presented to our institution with an acute myocardial infarction and underwent emergent angioplasty to his coronary vessels. The following day, he was seen by our department for bilateral blurring of vision which the patient described as being present since the onset of his cardiac symptoms, but now also associated with an unsteadiness of gait and weakness in his left upper and lower limbs. Examination revealed normal visual acuity (6/6 each eye) and a dense right homonymous hemianopia which was confirmed on Humphrey visual field testing (Fig. 1A). Fundoscopy showed a Purtscher-like retinopathy of both fundi (Fig. 1B). Of note, we did not visualize any macroscopic emboli in the retinal vessels.

Computed tomography images of the brain did not show any abnormalities and diffusion-weighted images on magnetic resonance imaging did not show evidence of any cerebrovascular accident. The patient had already underwent coronary vascular intervention and started on antiplatelet agents by the cardiologist, and no further treatment was instituted by us.

On review 2 weeks later, his homonymous hemianopia had improved (Fig. 2A) along with his Purtscher-like retinopathy (Fig. 2B). His neurological deficits had resolved within the first

Received 3 December 2015; received in revised form 10 May 2017; accepted 13 May 2017; available online 22 May 2017.

Department of Ophthalmology and Visual Sciences, Khoo Teck Puat Hospital, Singapore
National Healthcare Group Eye Institute, Singapore

* Corresponding author at: 3 Jalan Kebaya, Singapore 278291, Singapore.
e-mail address: lesjang@hotmail.com (L.J.P.S. Ang).

Peer review under responsibility of Saudi Ophthalmological Society, King Saud University

Production and hosting by Elsevier

Access this article online:
www.saudiophthaljournal.com
www.sciencedirect.com

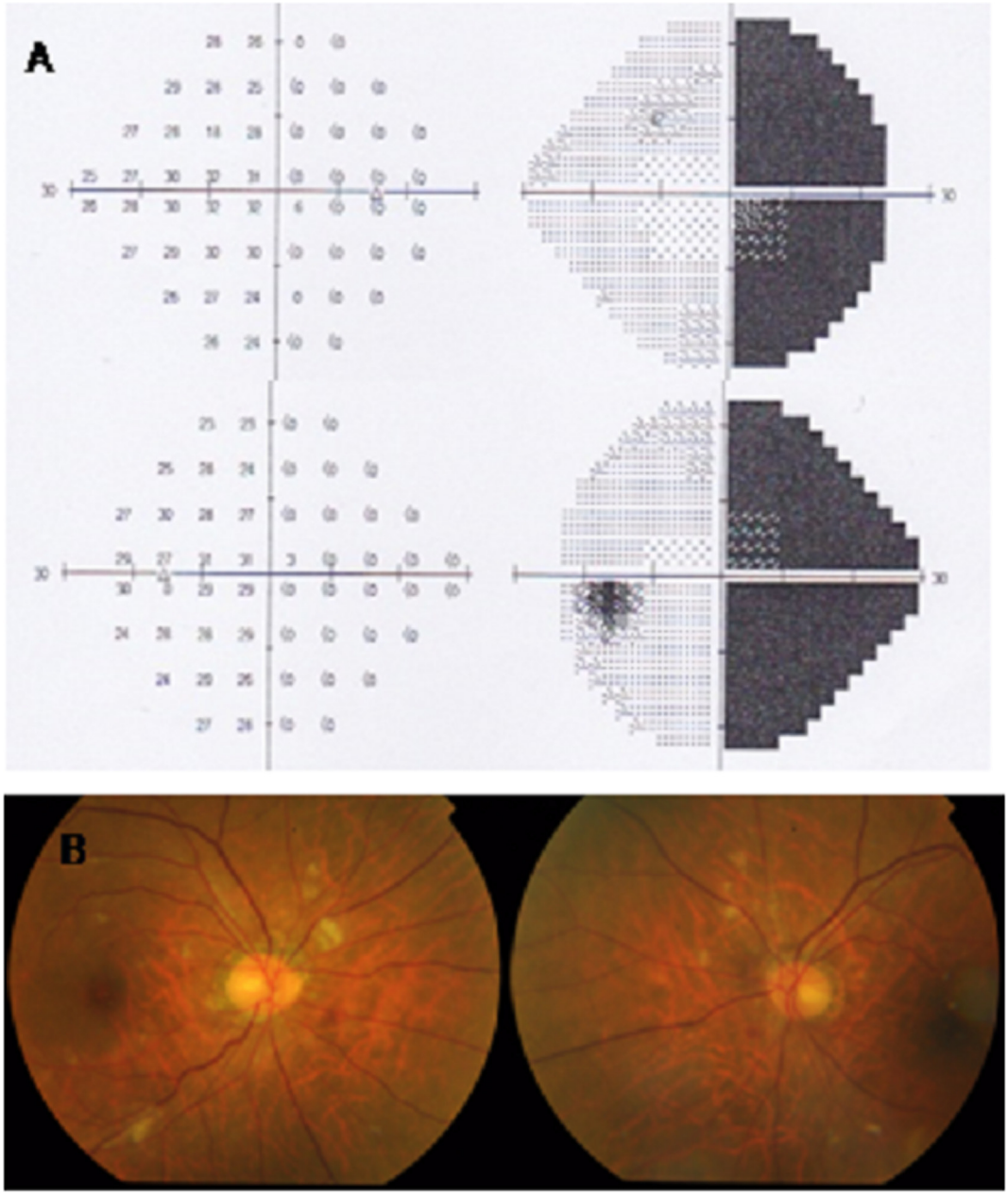

Figure 1. A. Humphrey visual fields showing a right homonymous hemianopia. B. Purtscher-like retinopathy of both eyes.

day of developing the symptoms, and was regarded and managed as a transient ischemic attack (TIA). A review 4 weeks after initial presentation showed complete resolution of Purtscher flecken and near complete resolution of his visual field defects.

Clinical features and presentation

PUR usually presents with a wide range of visual acuities, from a visual acuity (VA) of 6/6 with minimal visual disturbance, to severe visual loss with a vision of light perception.

The onset is usually immediate, but can be up to 48 h later depending on the etiology of the inciting event.[2] The delayed onset in some of the cases may not be a true time interval between the inciting event and the development of PUR, and the lack of any obvious injury to the eye could have resulted in a delayed referral to the ophthalmologist.

While PUR typically affects both eyes, there have been a number of reports of unilateral PUR.[3–8] Causes of unilateral PUR have included trauma,[5,9–11] retrobulbar anesthesia [7,12–14] and valsalva maneuver associated with weight lifting.[15] Relative afferent pupillary defects have been reported in unilateral disease[4] as well as bilateral disease,[16] which is indicative of the potential asymmetry of this condition.

Typical fundus findings include cotton wool spots and Purtscher flecken confined to the posterior pole surrounding the optic disk, rarely progressing beyond the mid peripheral retina. Purtscher flecken are discrete areas of retinal whitening in the superficial aspect of the inner retina. They can vary considerably in shape but tend to be polygonal. They also vary widely in size, and can be up to several disk diameters

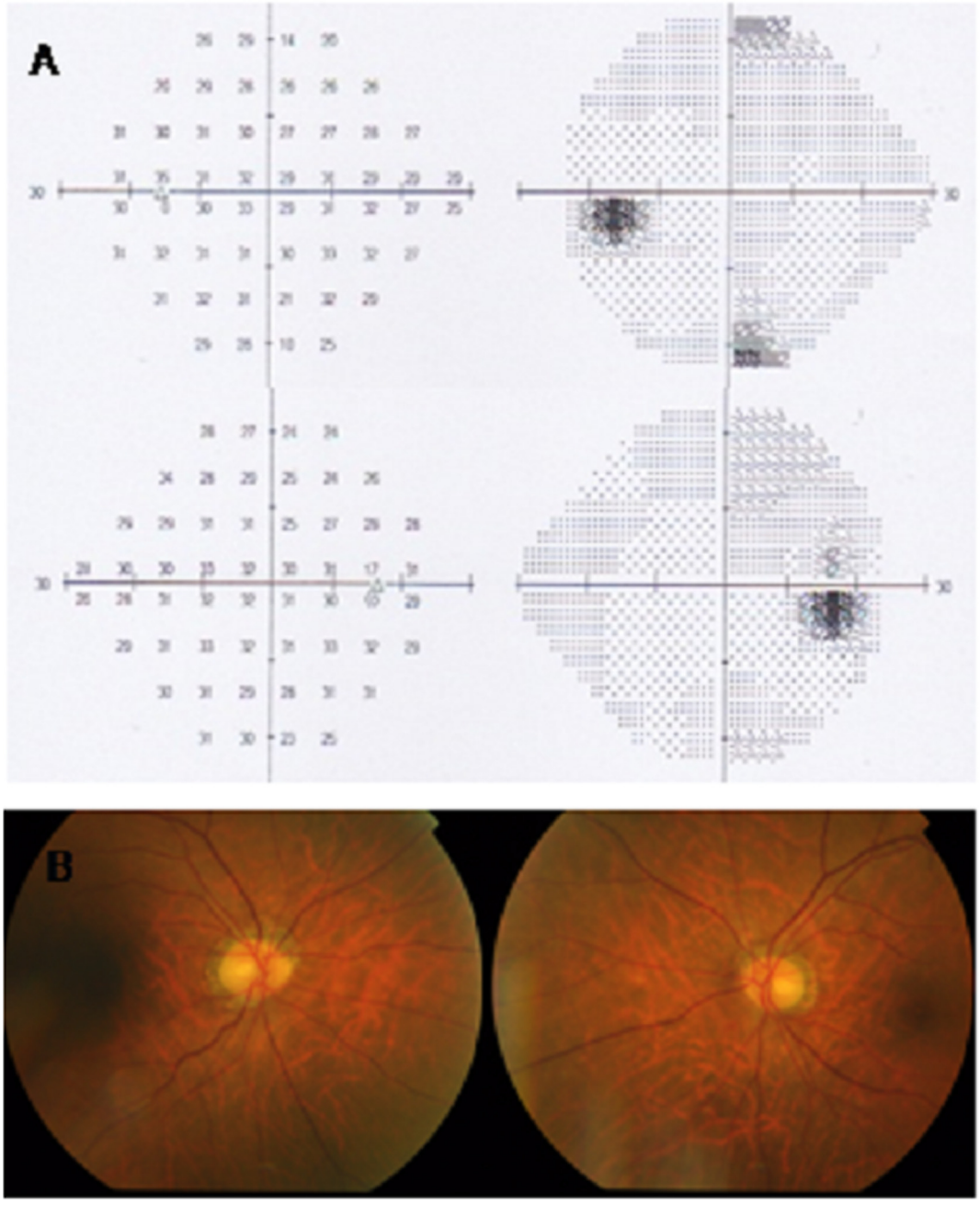

Figure 2. 2 weeks after presentation. A. Humphrey visual fields showing resolution of right homonymous hemianopia. B. Near complete resolution of Purtscher lesions in both eyes.

in size. The whitening may extend to the edge of an adjacent venule but there is typically a rim of clear retina beside an adjacent arteriole. There may be associated retinal haemorrhages (superficial and deep) but these are usually few in number. The haemorrhages are typically flame-shaped, but there may be dot and blot haemorrhages as well. Occasionally this may be associated with optic disk swelling. In addition, when the retinal whitening surrounds the fovea or when there is extensive macular edema, this can give rise to the appearance of a pseudo-cherry red spot, which is not an uncommon finding.[17]

In cases where formal visual fields have been performed, they generally show central or paracentral scotomas.[2,4] Our case is unique in that he presented with a homonymous hemianopia which has never been previously described. This visual field defect was likely a result of the transient ischemic attack (TIA) and has been reported to be a visual symptom in 12% of patients with TIA,[18] rather than from the PUR itself. While the MI and subsequent angioplasty may also cause an ischemic state in the retina and its vasculature, the homonymous pattern of the visual field defect and the accompanying neurological symptoms led the physicians and us to agree that these were likely a result of a TIA.

Pathogenesis

The original theory by Otmar Purtscher behind the pathogenesis of PUR was that of extravasation of lymph from retinal vessels following the sudden increase in intracranial

pressure secondary to severe head injury.[1] As similar clinical findings have been found in patients with various other conditions, a number of other theories have been proposed.[19]

One theory is that of retinal endothelial damage secondary to a sudden increase in intrathoracic pressure and a reflux within the venous system.[20] This causes an incompetence in the microvascular circulation, resulting in occlusion and ischemia.[21] Another theory is that of endothelial damage from free fatty acids and a lipase-induced vasculitis seen especially in patients following fat embolism syndrome and long-bone fractures.[22,23] This results in platelet aggregation, thrombosis, vascular obstruction and the clinical picture of PUR.[24] Interestingly, there was an isolated case report of PUR following dislocation and an avulsion fracture of the shoulder joint,[10] which does not cause fat embolism and indicates that other mechanisms must be in play.

Currently the most accepted theory is that of an embolic phenomenon resulting in occlusion of the precapillary arterioles. Air, fat, platelets, fibrin, leukocyte aggregates as well as exogenous particles are all potential emboli. Complement activation may induce the formation of these leukocyte aggregates in patients with acute pancreatitis,[25–28] while platelet aggregates and fibrin are more frequently seen in patients with thrombotic thrombocytopenic purpura, HELLP syndrome and other prothrombotic systemic conditions.[17,29–32] Air and fat emboli are typically described following long-bone fractures,[22,23] while severe trauma also results in complement activation and a prothrombotic state.

The embolic theory is able to explain the pathogenesis of PUR across a whole gamut of etiologies and the clinical course of our patient further substantiates this. It was previously believed that the myocardial injury in an MI leads to formation of a left ventricular thrombus which becomes the source of potential emboli,[33] and occurs in 0.6–3.7% of patients.[34] An alternative mechanism is that there is a period of increased coagulation activity, which leads to an increased incidence of thromboembolic phenomena.[35] In both cases, emboli are thrown off, and results in TIA or strokes in up to 1% of patients within 1 year of the MI.

As the retina and its vasculature have similar embryologic origins to the cerebral vasculature,[36] they share many anatomic and physiological similarities and have similar structural characteristics in them being end arteries. Retinal microvascular changes occur in cerebrovascular disease and Baker et al. have shown the association between retinal vascular findings and strokes.[37] Our patient suffered a TIA and PUR, both embolic complications following the MI, and further substantiates the latest pathogenic theory of PUR.

Investigations

The typical appearance of the macula on optical coherence tomography (OCT) at initial diagnosis is that of varying degrees of retinal thickening and edema[9,38–40] with some cases even having subretinal serous fluid.[41] Several months on, most cases have resolution of the thickening,[38–40] but some will still show retinal atrophy and destruction of the foveal architecture.[9] The damage is confined to not just the inner retinal layers but also the outer segment and the inner segment-outer segment junction of the photoreceptors in the outer retina.[42,43] This damage may portend a poorer visual prognosis.

Fundus autofluorescence typically shows hypofluorescence corresponding to the areas of retinal whitening and over the Purtscher lesions.[17,42] Interestingly, Giani et al. also reported hyperautofluorescence from some of the vessels which were associated with the ischemia, and postulated that this was due to the long-lasting retention and organization of blood in these occluded arterioles.[42,44]

The appearance of the retina on fluorescein angiography varies widely. The most frequently seen feature is that of retinal non-perfusion. The affected areas can be patchy or confluent and widespread.[38–40,45] They may occasionally be localized to the capillary bed of the retina in the region of the cotton-wool spots.[14,46] They are also often associated with varying degrees of macular ischemia[10,31,47] and can be asymmetrical between 2 eyes of the same patient.[48] Later stages of the angiogram may show macular edema.[9,39] There may be perivascular leakage or late staining of the affected arterioles and venules,[5,49,50] or more rarely, leakage from the optic nerve.[51] Some patients also present with multiple pinpoint hyperfluorescent areas with leakage in the later frames, without any fallout.[52] Indocyanine green angiography, when done, shows areas of choroidal non-perfusion, and this corresponds with the areas of non-perfusion seen on fluorescein angiography.[3,50]

Electrophysiological studies are uncommonly performed investigations. Electroretinogram shows both depressed a and b wave amplitudes.[39,53,54] This reflects damage to the Muller and Bipolar cells of the inner retina as well as the photoreceptors in the outer retina. Visual evoked potential (VEP) shows varied results, with an increased latency in the early stages of the disease,[9,11] but can also be normal.[55] This is not unexpected as the integrity of the primary and secondary visual cortices is intact.

Treatment

At present, there is no consensus on the treatment of PUR. Many different treatment options have been suggested and administered with differing outcomes.

The most frequent treatment prescribed is high-dose intravenous steroids, usually with a tapering dose of oral steroids subsequently. There have been isolated reports promoting the efficacy of systemic steroids in hastening the visual recovery of patients with PUR,[11,51] but there have likewise been reports where steroids appear to be of no additional benefit.[28] The rationale behind corticosteroid use is sound, with the ability to inhibit complement activation and granulocyte aggregation, as well as to allow nerve fiber recovery by stabilizing damaged neuronal membranes and microvascular channels.[25,56] There was an isolated report of the use of subtenon's Triamcinolone in the more severely affected eye of a patient with PUR following childbirth and resulted in limited visual recovery.[16] However, at this stage, the benefit of steroid use over observation has still not been established clearly. In PUR associated with systemic lupus erythematosus, Kunavisarut et al. treated their patients with intravitreal Bevacizumab, sub-tenon's Triamcinolone or both, and performed panretinal photocoagulation on most of their patients, resulting in stabilization of the retinal condition and also VA.[32] This is similar to the management of ischemic retinopathy from severe head trauma.[57] While PUR is usually more commonly seen in these patients, an idiopathic ischemic retinopathy

has also been described and should be kept in mind whether the absence of Purtscher flecken.

One of the less used options is that of Papaverine Hydrochloride, a peripheral vasodilator, which was postulated to increase choroidal and retinal blood flow and dilate retinal arterioles.[7,58] However, recent studies show that this is not the case.[59,60] More recently, there has been an increasing use of hyperbaric oxygen therapy in ophthalmic conditions such as non-arteritic ischemic optic neuropathy and central retinal artery occlusion.[6,61] Hyperbaric oxygen therapy increases the partial oxygen pressure in the lung and therefore increases oxygen supply to the choroids and inner retina,[62] and has been attempted in a patient with PUR following a thoracic contusion. However, only 1 of the 2 eyes had visual recovery and no conclusion can be drawn to its efficacy due to such limited reports.

In a recent report by Ortmaier et al., they treated a patient who developed PUR following a femoral shaft fracture with intravenous and oral Pentoxifylline as well as low molecular weight Heparin which resulted in good visual recovery.[63] Pentoxyfylline is typically used in patients with intermittent claudication to decrease the blood viscosity, and Heparin prevents deep vein thrombosis. However, the decrease in viscosity induced by these agents may have contributed to increased perfusion of the retinal vasculature as well as recanalisation of the occluded arterioles.

Our patient was treated conservatively and this is in-line with the recommendations of numerous reports.[2,28,64] Given the good central visual acuity, and having already instituted appropriate treatment of the underlying condition, this was felt to be the most reasonable course of action at the time, so as not to subject the patient to the potential side effects of high dose systemic steroids.

Clinical course and prognosis

Reports on the visual prognosis of patients with PUR are varied, ranging from a final acuity of 6/6, to patients with hand movement vision. Even within the same patient, both eyes may be affected asymmetrically and recover to different degrees.[16] Agrawal and McKibbin have postulated that clinical features which are associated with a poor long-term outcome included that of optic disk swelling or leakage and capillary non-perfusion on fluorescein angiography, as well as involvement of the outer retina.[2] A recent systematic review by Miguel et al.[64] has described the male gender, the absence of macular edema and the absence of a pseudo cherry red spot as good prognostic features. This improvement is most apparent within the first 2 months following the onset of PUR, although there are cases where visual recovery is more gradual and returns to baseline only after months or even years.[8,51,65]

PUR associated with systemic diseases such as chronic renal failure, acute pancreatitis, thrombotic thrombocytopenic purpura, systemic lupus, chemotherapy-related and pregnancy-related complications tended toward a worse visual outcome, with acuities being as poor as hand movements, while PUR associated with traumatic etiologies, such as long-bone fractures, chest compression, valsalva maneuvers and generalized trauma, tended to have better visual recovery, with many returning to their baseline VA within a few weeks to months.[64] This is likely because after the onetime initial insult was over and the patients' conditions stabilized, there was good reperfusion of the retina, washout of the inflammatory mediators and recanalisation of the microcirculation. In the study by Agrawal and McKibbin, 5 of 6 eyes in their patients with pancreatitis had poor visual recovery as compared to only 3 of 18 affected eyes in post-traumatic patients in their series.[2] In this respect, while our patient had suffered a global ischemic insult – in the form of a myocardial infarction, he still had good visual recovery as the condition was treated promptly with percutaneous coronary intervention.

Conclusion

We present for the first time, an interesting case of a patient developing PUR following an MI. This was also associated with the patient suffering a TIA. The incidence of a TIA or stroke after an acute MI is in the range of 1–2%.[66–68] While never reported before, as these 2 conditions share similar pathogenic mechanisms, there may be significant under-reporting of the incidence of PUR especially in post-MI patients.

At present, there is no consensus on the treatment of PUR, but previous reports have shown that prompt management of the underlying condition is crucial in giving the patient the best chance to restore vision. While our patient was fortunate to have full visual recovery with just observation, further studies would be necessary to evaluate whether this is truly the best course of action. Also, due to the rarity of the condition,[28] prospective trials on this condition will have to take the form of multicenter national or international studies.

Conflict of interest

The authors declared that there is no conflict of interest.

References

1. Purtscher O. Noch unbekannte befunde nach schadeltrauma. *Ber Dtsch Ophthalmol Ges* 1910;**36**:294–301.
2. Agrawal A, McKibbin MA. Purtscher's and Purtscher-like retinopathies: a review. *Surv Ophthalmol* 2006;**51**(2):129–36, Mar-Apr.
3. Kocak N, Kaynak S, Kaynak T, Oner HF, Cingil G. Unilateral Purtscher-like retinopathy after weight-lifting. *Eur J Ophthalmol* 2003;**13**(4):395–7.
4. Kuroda M, Nishida A, Kikuchi M, Kurimoto Y. Purtscher's retinopathy followed by neovascular glaucoma. *Clin Ophthalmol* 2013;**7**:2235–7.
5. Teichmann KD, Gronemeyer U. Unilateral morbus Purtscher with poor visual outcome. *Ann Ophthalmol* 1981;**13**(11):1295–9.
6. Bojić L, Ivanisević M, Gosović G. Hyperbaric oxygen therapy in two patients with non-arteritic anterior optic neuropathy who did not respond to prednisone. *Undersea Hyperb Med* 2002;**29**:86–92.
7. Lemagne JM, Michiels X, Van Causenbroeck S, et al. Purtscher-like retinopathy after retrobulbar anesthesia. *Ophthalmology* 1990;**97**:859–61.
8. Burton TC. Unilateral Purtscher's retinopathy. *Ophthalmology* 1980;**87**:1096–105.
9. Miguel A, Lopes N, Neves M, Andres R, Henriques F, Roque-Loureiro A. Purtscher's retinopathy with contralateral traumatic optic neuropathy – case report. *Oftalmologia* 2010;**34**(2):399–405.
10. Nayak H, Harun S, Palimar P. Purtscher's retinopathy after fracture dislocation of shoulder joint. *Emerg Med J* 2005;**22**(11):831–2.
11. Atabay C, Kansu T, Nurlu G. Late visual recovery after intravenous methylprednisolone treatment of Purtscher's retinopathy. *Ann Ophthalmol* 1993;**25**(9):330–3.
12. Cho HK, Jee D, Lee WK, Shin CH, Ryu JW. Purtscher-like retinopathy after retrobulbar anaesthesia in a patient with an intracanal mass. *Can J Ophthalmol* 2010 Oct;**45**(5):546–7.

13. Lim BA, Ang CL. Purtscher-like retinopathy after retrobulbar injection. *Ophthalmic Surg Lasers* 2001;**32**(6):477–8, Nov-Dec.
14. Blodi BA, Williams CA. Purtscher-like retinopathy after uncomplicated administration of retrobulbar anesthesia. *Am J Ophthalmol* 1997 Nov;**124**(5):702–3.
15. Nor-Masniwati S, Azhany Y, Zunaina E. Purtscher-like retinopathy following valsalva maneuver effect: case report. *J Med Case Rep* 2011;**1**(5):338.
16. Olson J, Rouhani B, Mandava N. Sub-Tenon's triamcinolone for post-partum Purtscher's-like retinopathy. *Clin Ophthalmol* 2008;**2**(1):195–8.
17. Wu C, Dai R, Dong F, Wang Q. Purtscher-like retinopathy in systemic lupus erythematosus. *Am J Ophthalmol* 2014;**158**(6), Dec, 1335–1341.e1.
18. Lavallée PC, Cabrejo L, Labreuche J, Mazighi M, Meseguer E, Guidoux C, et al. Spectrum of transient visual symptoms in a transient ischemic attack cohort. *Stroke* 2013 Dec;**44**(12):3312–7.
19. Buckley SA, James B. Purtscher's retinopathy. *Postgrad Med J* 1996 Jul;**72**(849):409–12.
20. Lin YC, Yang CM, Lin CL. Hyperbaric oxygen treatment in Purtscher's retinopathy induced by chest injury. *J Chin Med Assoc* 2006 Sep; **69**(9):444–8.
21. Shah GK, Penne R, Grand MG. Purtscher's retinopathy secondary to airbag injury. *Retina* 2001;**21**:68–9.
22. Chuang EL, Miller FS, Kalina RE. Retinal lesions following long bone fractures. *Ophthalmology* 1985;**92**:370–4.
23. Mellor A, Soni N. Fat embolism. *Anaesthesia* 2001;**56**:145–54.
24. Roden D, Fitzpatrick G, O'Donoghue H, Phelan D. Purtscher's retinopathy and fat embolism. *Br J Ophthalmol* 1989; **73**(8):677–9.
25. Jacob HS, Craddock PR, Hammerschmidt DE, et al. Complement-induced granulocyte aggregation: an unsuspected mechanism of disease. *N Engl J Med* 1980;**302**:789–94.
26. Jacob HS, Goldstein IM, Shapiro I, et al. Sudden blindness in acute pancreatitis. Possible role of complement-induced retinal leukoembolization. *Arch Intern Med* 1981;**141**:134–6.
27. Mayer C, Khoramnia R. Purtscher-like retinopathy caused by acute pancreatitis. *Lancet* 2011;**378**(9803):1653, Nov 5.
28. Agrawal A, McKibbin M. Purtscher's retinopathy: epidemiology, clinical features and outcome. *Br J Ophthalmol* 2007;**91**(11):1456–9.
29. Stewart MW, Brazis PW, Guier CP, Thota SH, Wilson SD. Purtscher-like retinopathy in a patient with HELLP syndrome. *Am J Ophthalmol* 2007;**143**(5):886–7.
30. Cernea D, Dragoescu A, Novac M. HELLP syndrome complicated with postpartum subcapsular ruptured liver hematoma and Purtscher-like retinopathy. *Case Rep Obstet Gynecol* 2012;**2012**:856135. http://dx.doi.org/10.1155/2012/856135.
31. Patel MR, Bains AK, O'Hara JP, et al. Purtscher's retinopathy as the initial sign of thrombotic thrombocytopenic purpura/hemolytic uremic syndrome. *Arch Ophthalmol* 2001;**119**:1388–9.
32. Kunavisarut P, Pathanapitoon K, Rothova A. Purtscher-like retinopathy associated with systemic lupus erythematosus. *Ocul Immunol Inflamm* 2014 Jul;**14**:1–9.
33. Dutta M, Hanna E, Das P, Steinhubl SR. Incidence and prevention of ischemic stroke following myocardial infarction: review of current literature. *Cerebrovasc Dis* 2006;**22**(5–6):331–9.
34. Greaves SC, Zhi G, Lee RT, et al. Incidence and natural history of left ventricular thrombus following anterior wall acute myocardial infarction. *Am J Cardiol* 1997;**80**:442–8.
35. Merlini PA, Bauer KA, Oltrona L, et al. Persistent activation of coagulation mechanism in unstable angina and myocardial infarction. *Circulation* 1994;**90**:61–8.
36. Tso MO, Jampol LM. Pathophysiology of hypertensive retinopathy. *Ophthalmology* 1982;**89**:1132–45.
37. Baker ML, Hand PJ, Wang JJ, Wong TY. Retinal signs and stroke: revisiting the link between the eye and brain. *Stroke* 2008 Apr; **39**(4):1371–9.
38. Alasil T, Tokuhara K, Bowes LD, Fan J. Purtscher-like retinopathy: optical coherence tomography and visual field findings. *Ophthalmic Surg Lasers Imaging* 2010;**9**:1–4.
39. Holak HM, Holak NH, Schenk C, Olinger A, Holak SA. Correlation of retinal thickness with the extent of Purtscher's retinopathy. *Ophthalmologe* 2006;**103**(9):798–805.
40. Carrera CR, Pierre LM, Medina FM, Pierre P. Purtscher-like retinopathy associated with acute pancreatitis. *Sao Paulo Med J* 2005;**123**(6):289–91.
41. Okwuosa TM, Lee EW, Starosta M, Chohan S, Volkov S, Flicker M, et al. Purtscher-like retinopathy in a patient with adult-onset Still's disease and concurrent thrombotic thrombocytopenic purpura. *Arthritis Rheum* 2007;**57**(1):182–5.
42. Giani A, Deiro AP, Sabella P, Eandi CM. Spectral domain-optical coherence tomography and fundus autofluorescence findings in a case of purtscher-like retinopathy. *Retin Cases Brief Rep* 2011; **5**(2):167–70, Spring.
43. Kincaid MC, Green WR, Knox DL, Mohler C. A clinicopathological case report of retinopathy of pancreatitis. *Br J Ophthalmol* 1982;**66**:219–26.
44. Schmitz-Valckenberg S, Holz FG, Bird AC, Spaide RF. Fundus autofluorescence imaging: review and perspectives. *Retina* 2008;**28**:385–409.
45. Ong T, Nolan W, Jagger J. Purtscher-like retinopathy as an initial presentation of thrombotic thrombocytopenic purpura: a case report. *Eye (Lond)* 2005;**19**(3):359–61.
46. Proenc¸a Pina J, Ssi-Yan-Kai K, de Monchy I, Charpentier B, Offret H, Labetoulle M. Purtscher-like retinopathy: case report and review of the literature. *J Fr Ophtalmol* 2008;**31**(6):609.
47. Sellami D, Ben Zina Z, Jelliti B, Abid D, Feki J, Chaabouni M. Purtscher-like retinopathy in systemic lupus erythematosus. Two cases. *J Fr Ophtalmol* 2002;**25**(1):52–5.
48. Banach MJ, Williams GA. Purtscher retinopathy and necrotizing vasculitis with gemcitabine therapy. *Arch Ophthalmol* 2000; **118**(5):726–7.
49. Bui SK, O'Brien JM, Cunningham Jr ET. Purtscher retinopathy following drug-induced pancreatitis in an HIV positive patient. *Retina* 2001;**21**(5):542–5.
50. Fumex L, Boizard Y, Burillon C, Denis P. Purtscher retinopathy in acute alcoholic pancreatitis. A case report. *J Fr Ophtalmol* 2004; **27**(8):927–31.
51. Wang AG, Yen MY, Liu JH. Pathogenesis and neuroprotective treatment in Purtscher's retinopathy. *Jpn J Ophthalmol* 1998;**42**:318–22.
52. Lai WW, Chen AC, Sharma MC, Lam DS, Pulido JS. Purtscher-like retinopathy associated with acute renal allograft rejection. *Retina* 2005;**25**(1):85–7.
53. Sauer A, Nasica X, Zorn F, Petitjean P, Bader P, Speeg-Schatz C, et al. Cryoglobulinemia revealed by a Purtscher-like retinopathy. *Clin Ophthalmol* 2007;**1**(4):555–7.
54. Haq F, Vajaranant TS, Szlyk JP, Pulido JS. Sequential multifocal electroretinogram findings in a case of Purtscher-like retinopathy. *Am J Ophthalmol* 2002;**134**(1):125–8.
55. Baarsma GS, van Balen TM. Purtscher's disease. *Doc Ophthalmol* 1977;**44**(1):95–104.
56. Hammerschmidt DE, White JG, Craddock PR, et al. Corticosteroids inhibit complement-induced granulocyte aggregation. A possible mechanism for their efficacy in shock states. *J Clin Invest* 1979;**63**:798–803.
57. Coban-Karatas M, Altan-Yaycioglu R. Ischemic retinopathy and neovascular proliferation secondary to severe head injury. *Case Rep Ophthalmol Med* 2014;**2014**:410289.
58. Frayser R, Hickam JB. Effect of vasodilator drugs on the retinal blood flow in man. *Arch Ophthalmol* 1965;**73**:640–2.
59. Schmidl D, Pemp B, Lasta M, Boltz A, Kaya S, Palkovits S, et al. Effects of orally administered moxaverine on ocular blood flow in healthy subjects. *Graefes Arch Clin Exp Ophthalmol* 2013 Feb; **251**(2):515–20.
60. Pemp B, Garhofer G, Lasta M, Schmidl D, Wolzt M, Schmetterer L. The effects of moxaverine on ocular blood flow in patients with age-related macular degeneration or primary open angle glaucoma and in healthy control subjects. *Acta Ophthalmol* 2012;**90**(2):139–45.
61. Beiran I, Goldenberg I, Adir Y, Tamir A, Shupak A, Miller B. Early hyperbaric oxygen therapy for retinal artery occlusion. *Eur J Ophthalmol* 2001;**11**:345–50.
62. Dollery CT, Bulpitt CJ, Kohner EM. Oxygen supply to the retina from the retinal and choroidal circulation at normal and increased arterial oxygen tension. *Invest Ophthalmol* 1969;**8**:588–94.
63. Ortmaier R, Resch H, Stieböck C, Arlt EM. Purtscher's retinopathy after intramedullary nailing of a femoral shaft fracture in a 20-year old healthy female -report of a rare case and review of the literature. *BMC Musculoskelet Disord* 2014 Feb;**19**(15):42.
64. Miguel AI, Henriques F, Azevedo LF, Loureiro AJ, Maberley DA. Systematic review of Purtscher's and Purtscher-like retinopathies. *Eye (Lond)* 2013;**27**(1):1–13.

65. Wilkinson WS, Morgan CM, Baruh E, et al. Retinal and choroidal vascular occlusion secondary to corticosteroid embolisation. *Br J Ophthalmol* 1989;**73**:32–4.
66. Tanne D, Goldbourt U, Zion M, Reicher-Reiss H, Kaplinsky E, Behar S. Frequency and prognosis of stroke/TIA among 4808 survivors of acute myocardial infarction. The SPRINT Study Group. *Stroke* 1993;**24**(10):1490–5.
67. Fibrinolytic Therapy Trialists' Collaborative Group. Overview of early mortality and major morbidity results from all randomized trials of more than 1000 patients. *Lancet* 1994;**343**:311–22.
68. Wienbergen H, Schiele R, Gitt AK, et al. Incidence, risk factors, and clinical outcome of stroke after acute myocardial infarction in clinical practice. *Am J Cardiol* 2001;**87**:782–5.