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Journal of Current Ophthalmology 30 (2018) 263–267
http://www.journals.elsevier.com/journal-of-current-ophthalmology

Brief report

Evaluation of rhegmatogenous retinal detachments using Optos ultrawide field fundus fluorescein angiography and comparison with ETDRS 7 field overlay

Koushik Tripathy, Rohan Chawla*, Bhushan Ratansingh Wadekar, Pradeep Venkatesh, Yog Raj Sharma

Department of Retina and Uvea, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India

Received 11 May 2018; revised 11 June 2018; accepted 18 June 2018
Available online 3 July 2018

Abstract

Purpose: To evaluate the ultrawide field fundus fluorescein angiography (UWFA) characteristics of rhegmatogenous retinal detachments (RRDs) and compare the findings with an early treatment diabetic retinopathy study (ETDRS) 7 field (ETDRS7F) overlay.
Methods: UWFA (Optos, PLC, Dunfermline, UK) was performed in 10 eyes with macula-off RRDs in 9 patients. The findings of UWFA were compared with that of an overlay of standard ETDRS7F.
Results: Vascular dilation, tortuosity of vessels, and blockage of choroidal fluorescence were noted in all eyes in both UWFA and ETDRS7F overlay. Other findings in UWFA and ETDRS7F included peripheral perivascular staining (10 versus 4 eyes), peripheral capillary nonperfusion (CNP) (9 eyes compared to none), vascular loop formation (7 eyes versus none), optic disc hyperfluorescence (5 eyes in both), petaloid leak at macula (2 eyes in both), and neovascularization elsewhere (3 eyes versus none).
Conclusions: Peripheral perivascular staining and leak, CNP, and vascular tortuosity are common UWFA features of RRDs. Standard ETDRS7F missed peripheral CNP, peripheral vascular loops, and peripheral retinal new vessels in all eyes compared to UWFA in the current study.
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Keywords: Capillary nonperfusion; Perivascular leak; Vascular loop; Arteriovenous shunt; Retinal neovascularization; Neovascularization of iris

Introduction

Ultrawide field fundus imaging (Optos PLC, Dunfermline, UK) captures 82% (200°) of retina even through a small pupil, giving a pseudo color fundus image, fluorescein angiogram, and autofluorescence image.[1] Vascular changes associated with rhegmatogenous retinal detachments (RRDs) have been studied by routine fluorescein angiography.[2–5] However, to the best of the authors' knowledge, no previous study explored the angiographic features using Optos single panoramic ultrawide field fundus fluorescein angiogram (UWFA). The authors evaluated the UWFA features of RRDs in this study and compared the findings with the standard early treatment diabetic retinopathy study (ETDRS) 7 field (ETDRS7F) overlay.

Meeting presentation: A part of the manuscript was presented at *The 2015 ARVO Annual Meeting, Powerful Connections: Vision Research and Online Networking; Denver, Colorado* held in May 2015; and All India Ophthalmology Conference, 2018.

Conflict of interest: All the authors declare that they have no conflict of interest.

Financial interests: All authors have no financial interests to disclose.

* Corresponding author. Department of Retina and Uvea, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, 110029, India.

E-mail address: dr.rohanrpc@gmail.com (R. Chawla).

Peer review under responsibility of the Iranian Society of Ophthalmology.

https://doi.org/10.1016/j.joco.2018.06.006
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Table 1
Summary of ultrawide field fundus fluorescein angiographic (UWFA) findings noted in our study compared to an overlay of early treatment diabetic retinopathy study 7 field (ETDRS7F).

	Eyes (n = 10) UWFA finding	ETDRS7F features
Blockage of choroidal fluorescence	10	10
Vascular dilatation	10	10
Vascular tortuosity	10	10
Peripheral perivascular stain and leak	10	4
Peripheral Capillary non-perfusion	9	0
Peripheral vascular loop formation	7	0
Optic disc leak	5	5
Petaloid leak at macula	2	2
Neovascularization elsewhere	3	0

UWFA: Ultrawide field fundus fluorescein angiographic, ETDRS7F: Early treatment diabetic retinopathy study 7 field.

Methods

UWFA was performed in 10 eyes of 9 patients with RRD involving the macula. The imaging protocol included single central UWFA along with 4 images with the patient looking up, down, right, and left both in the early and late phase of the fluorescein angiogram. Patients with hypertension, diabetes, and a history of premature birth were excluded. Other exclusion criteria included retinal vascular diseases (retinal vascular occlusions, diabetic retinopathy, vasculitis, familial exudative vitreoretinopathy, carotid occlusive disease), and history of penetrating trauma. The features were evaluated by two experienced retina consultants (R.C. and K.T.) independently and only the features to which both of them agreed upon were included. An overlay of 7 fields (30° each) as per the standard ETDRS protocol/Modified Airlie house classification used by the diabetic retinopathy study[6] was superimposed on the UWFA using Microsoft® PowerPoint. The findings visible within the area of this ETDRS7F were then compared with UWFA. The tenets of the Declaration of Helsinki were followed throughout patient care. UWFA was performed after written informed consent. No adverse reaction to fluorescein dye was noted although 3 patients complained of nausea at the time of the procedure.

Results

A total of 10 eyes of 9 patients (3 males and 6 females) were studied. The age ranged from 15 to 60 years, with mean (±standard deviation, SD) 30.22 (±17.1) years and a median of 23 years. The mean (±SD) duration of symptoms was 13.6 (±16) weeks with a median of 10 weeks (range, 1–52 weeks). On UWFA and ETDRS7F, blockage of choroidal fluorescence and dilated/tortuous vessels were noted in all eyes at the area of RRDs (Table 1). UWFA revealed some amount of peripheral perivascular stain and leak (Fig. 1-triangle) in all eyes, while it was noted in 4 eyes with ETDRS7F. Peripheral capillary nonperfusion (CNP) was noted in all eyes with

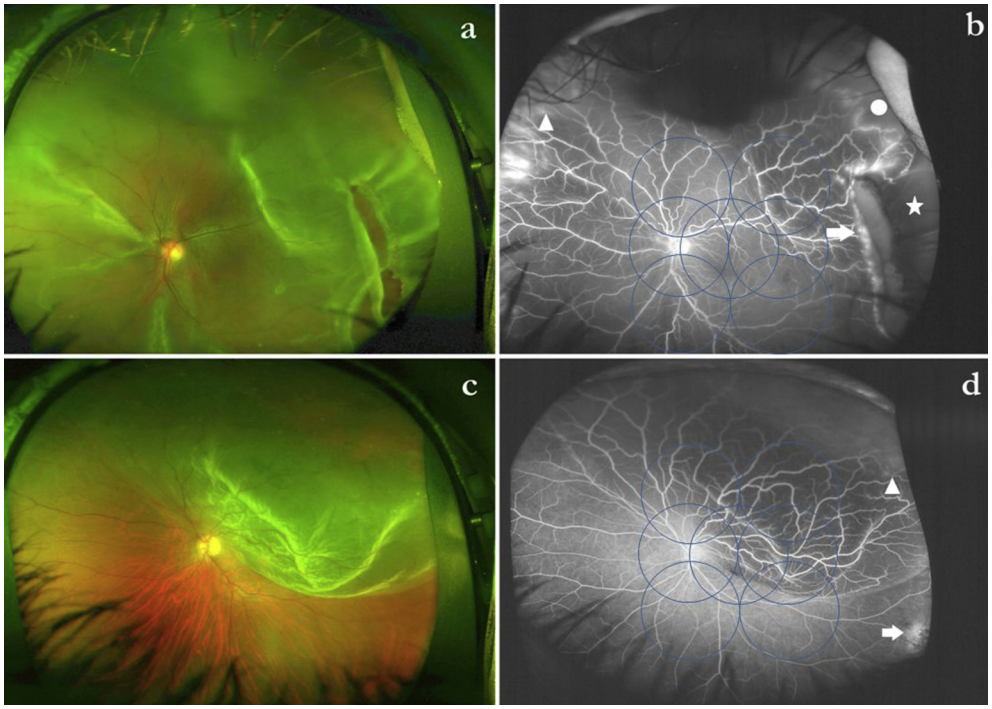

Fig. 1. a – Eye 2 presented with a total rhegmatogenous retinal detachment (RRD) with a large temporal break at the posterior edge of a lattice with vitreoretinal traction. b – Ultrawide field fluorescein angiogram [with early treatment diabetic retinopathy study 7 field (ETDRS7F) overlay] of eye 2 shows retinal capillary nonperfusion (CNP) (round dot) and multiple pinpoint leaks at the posterior edge of the large retinal break showed corresponding to ruptured retinal vessels (arrow). There was no dye transit to the anterior flap (star). c – Eye 3 had a fresh superotemporal retinal detachment. d – Ultrawide field fundus fluorescein angiography (UWFA) (with ETDRS7F overlay) demonstrated mild perivascular stain and leak (triangle) with no obvious peripheral CNP. Inferotemporal lattice caused window defects (arrow).

Table 2
Features of rhegmatogenous retinal detachment (RRD) on Optos ultrawide field fundus fluorescein angiography (UWFA) compared to an early treatment diabetic retinopathy study 7 field (ETDRS7F) overlay.

Eye no.	Age (years)	Sex	Duration (weeks)	Visual acuity	Involvement (quadrant)	Causative lesion	Other features	Capillary nonperfusion (UWFA)	Capillary nonperfusion (ETDRS7F)	Peripheral Vascular loop (UWFA)	Peripheral Vascular loop (ETDRS7F)	Disc hyper-fluorescence	Macular petaloid leak	Retinal neovascularization (UWFA)	Retinal neovascularization (ETDRS7F)	Blockage of choroidal fluorescence	Venous dilation and tortuosity	Paravascular stain (UWFA)	Paravascular stain (ETDRS7F)	Others
1	30	F	1	HMCF	4	ST retinal dialysis	Inferiorly bullous	+	−	−	−	+	−	−	−	+	+	+	+	
2	14	F	2	HMCF	4	Lattice with break		+	−	+	−	+	−	−	−	+	+	+	+	Absent dye in anterior flap, pinpoint leaks at torn vessels at the posterior edge of break
3	32	M	1	FCCF	1.5 (ST)	Lattice with holes ST, IT, temporal	Inferior lattice without hole	−	−	−	−	−	−	−	−	+	+	+	−	Window defect at lattice in attached retina
4	23	F	16	FCCF	3, SN attached	IT retinal dialysis	Demarcation lines superiorly	+	−	+		−	−	−	−	+	+	+	+	Window defect and block fluorescence at and around demarcation line
5	18	M	28	6/36	2, inferior	IT dialysis of young	Multiple demarcation lines, subretinal band	+	−	+	−	−	−	−	−	+	+	+	−	Window defect and block fluorescence at and around demarcation lines
6	60	M	16	PL	4	ST retinal break	Inferiorly bullous	+	−	−	−	+	+	−	−	+	+	+	−	
7	23	F	52	FCCF	3, SN attached	IT lattice with holes	Cystoid macular edema, temporal retinal macrocysts and preretinal neovascularizations	+	−	+	−	+	+	+	−	+	+	+	+	Accumulation of dye in retinal macrocysts
8	57	F	8	FCCF	2, temporal RRD	ST horse shoe tear with rolled edge	Posterior vitreous detachment induced vitreous hemorrhage	+	−	+	−	−	−	−	−	+	+	+	−	No dye in anterior flap of break
9	15	F	2	1/60	3.5, IN attached	Temporal lattice with holes		+	−	+	−	−	−	+	−	+	+	+	−	
10	15	F	12	3/60	2, inferior	Temporal lattice with holes	Multiple demarcation lines, subretinal band	+	−	+	−	+	−	+	−	+	+	+	−	Window defect and block fluorescence at and around demarcation lines

+: Present, −: Absent, HMCF: Hand movements close to face, FCCF: Finger counting close to face, PL: Perception of light, ST: Superotemporal, SN: Superonasal, IT: Inferotemporal, IN: Inferonasal, M: Male, F: Female, ACIOL: Anterior chamber intraocular lens, DS: Spherical diopters, RRD: Rhegmatogenous retinal detachment.

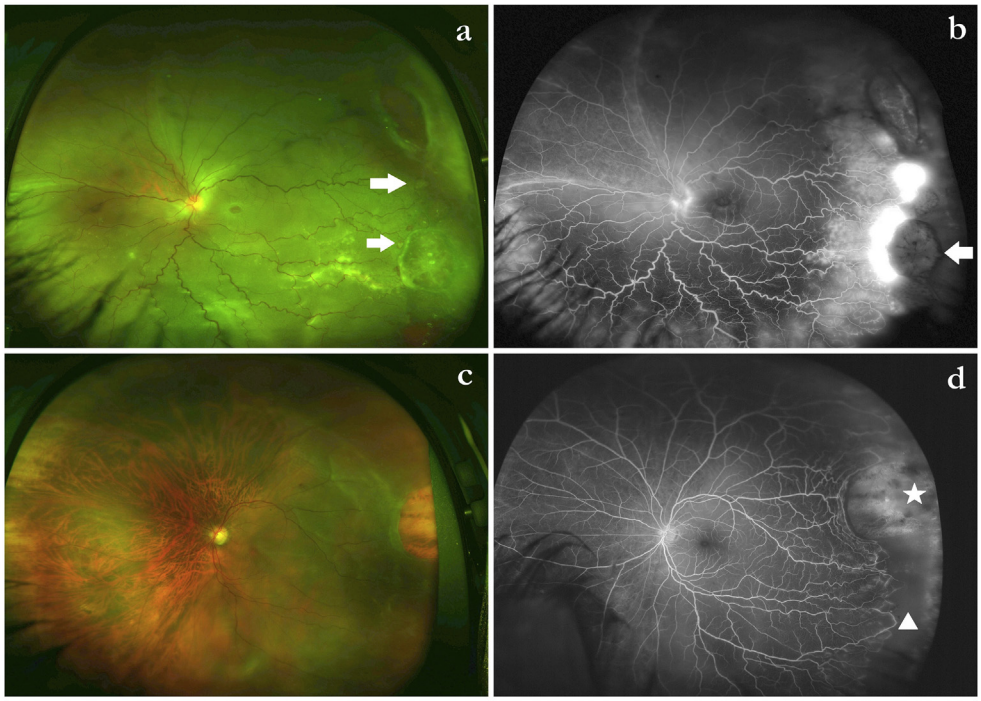

Fig. 2. a – Eye 7 had an old retinal detachment, cystoid macular edema (CME), large intraretinal macrocysts, and preretinal neovascularization (arrows). b – Ultrawide field fluorescein angiogram revealed perivascular leakage, capillary nonperfusion (CNP), preretinal neovascularizations, accumulation of dye in the macrocysts (arrow), optic disc hyperfluorescence, vascular loops, and petaloid leak at the macula. c – A temporal retinal detachment and a large superotemporal horse shoe tear with rolled edges were noted in eye 8. d – On Ultrawide field fluorescein angiogram showed vascular loops/arteriovenous shunts (triangle), CNP areas, and perivascular leak. The anterior flap of the break did not show dye transit (star).

UWFA (Table 2, Fig. 1-round dot) except in eye 3, which had a superotemporal fresh RRD. Other UWFA findings included peripheral vascular loop (7 eyes, Fig. 2d-triangle), disc hyperfluorescence (5 eyes), retinal neovascularization (3 eyes, Fig. 2b), and petaloid leak of the macula (2 eyes, Fig. 2b). ETDRS7F failed to detect peripheral CNP, vascular loop, or retinal new vessels. In large tears, the fluorescence was absent in the anterior flap (Figs. 1b and 2d). The peripheral retinal macrocysts were noted to fill with fluorescein dye in late phase in eye 7 (Fig. 2). This eye had an old subtotal RRD, cystoid macular edema (CME), large intraretinal macrocysts temporally, and superotemporally with preretinal neovascularization (temporally and inferotemporally).

Discussion

Ultrawide field imaging (Optos) has been used to evaluate various posterior segment disorders including dystrophies,[7–9] intraocular inflammation,[1,10,11] and intraocular[12]/periocular infection.[13] Optos has also been used to image RRDs before and after retinal reattachment surgery.[14] Witmer and colleagues found that Optos autofluorescence may be helpful in documenting the demarcation of the extent of RRDs.[15]

Vascular changes following RRD using standard fluorescein angiography include slow fluorescein filling pattern, dilated retinal capillaries, leakage of dye from retinal veins and retinal capillaries, retinal new vessels, and arteriovenous shunts.[2–5] In a study on 50 cases of RRDs, Piccolino[4] noted peripheral ischemia in 27 cases, most commonly in eyes with peripheral retinal holes. Minoda and Kanagami[16] noted peripheral vascular obliteration (64 eyes), vascular leakage (61 eyes), vasodilation (60 eyes), arteriovenous shunts (42 eyes), microaneurysm-like dilatation of the retinal capillaries near arteriovenous shunts, and terminal bud or club-like appearance of the terminal vessels at the borderline of the avascular area in an angiography study on 100 eyes with RRDs.

We found some peripheral CNP in all cases except one fresh RRD (eye 3). Perivascular leakage from peripheral smaller retinal vessels was evident in all 10 eyes. The amount of peripheral leakage and area of CNP seen appeared to be more in older retinal detachments. However, no definite correlation between the amount of perivascular leakage and magnitude of CNP can be made from this study as we did not quantify the areas of leakage and CNP. The number of cases in this study is small to derive such a conclusion. Another limitation of our study is that we did not perform optical coherence tomography of macula in any eyes including the eyes that showed petaloid macular leak. Abrupt termination of retinal vessels or formation of closed vascular loops was seen in few cases. Peripheral retinal avascularity has also been reported in the normal population using UWFA.[17] The distance of the peripheral perfused vascular border from the optic disc was shorter in older individuals (≥60 years) compared to the younger subjects.[17] Ophthalmoscopically, peripheral avascular area spans 0.5 disc diameters[18] behind ora serrata, and angiographically, it is 1 mm wide.[19] Kaneko and colleagues[20] noted peripheral retinal capillary telangiectasia in 81% of emmetropic eyes and 78.3% in eyes with pathological myopia.

Other features noted in pathological myopia (>8 D myopia, and axial length of >26.5 mm) compared to emmetropia included peripheral CNP (82.6% versus 4.8%), retinal capillary microaneurysm (52.2% versus 31%), and dye leakage from microaneurysm or telangiectasia (28.7% versus 0%).[20] None of our eyes had a myopia of more than 6 D. The CNP seen in RRDs may be related to better visibility of peripheral retina due to retinal detachment as suggested by Chen and coauthors.[21] Other vascular causes of peripheral CNP were excluded from our series. The outer retinal ischemia consequent to the retinal detachment and increased resistance[4] for vascular flow through the retinal vessels may also contribute to the exaggeration of a CNP. Chen and colleagues[21] evaluated the peripheral retinal vascular pattern in 73 RRDs using HRA II (Heidelberg retinal angiography, Heidelberg, Germany) with a 55° lens. They noted that peripheral CNP was more seen in younger patients with longer axial length.[21]

The amount of disc hyperfluorescence may probably be secondary to an element of uveitis induced by the retinal detachment. Also, the capillary dilatation and hyperpermeability may be related to an autoregulation process secondary to the hypoxia of outer retinal layers and resultant toxic metabolic products.[4] Minoda and Kanagami[16] reported that fellow eyes with attached retina also showed peripheral vascular obliteration, arteriovenous shunts, and vascular dilation while only a few eyes revealed vascular leakage. However, the fellow eyes did not show vascular changes in clinical exam or UWFA in this study. Absence of astrocytes at the hypoxic retina may also have a role in paravascular leakage.[21]

UWFA shows a larger area than ETDRS7F and can give ora to ora imaging if images are taken with care at extreme of gazes with separation of eyelids, and may give much more information than ETDRS7F. In our study, an ETDRS7F overlay failed to detect peripheral CNP, peripheral vascular shunts, and new vessels. The presence of peripheral CNP in a majority of our patients may explain the retinal or iris neovascularization in old RRDs. Larger studies are required to further explore and confirm this finding.

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