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.

Copyright © 2018, Iranian Society of Ophthalmology. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

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.1–5 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.
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 dilation | 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 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 hyperfluorescence | Macular petaloid leak | Retinal neovascularization (UWFA) | Retinal neovascularization (ETDRS7F) | Blockage of choroidal fluorescence and tortuosity | Paravascular stain (UWFA) | Paravascular stain (ETDRS7F) | Others |
|---------|-------------|-----|------------------|---------------|------------------------|-----------------|---------------|-----------------------------|-------------------------------|-------------------------------|-------------------------------|----------------|----------------|-----------------------------|-----------------------------|---------------------------------|----------------|----------------|-------|
| 1       | 30          | F   | 1                | HMCF          | ST retinal dialysis    | Lattice with break | Inferiorly bullous | +                          | -                            | -                             | -                             | +                           | +                           | +                           | +                           | +                             | +                             | +                          |
| 2       | 14          | F   | 2                | HMCF          | ST retinal dialysis    | Lattice with break | +                          | -                            | +                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             | +                          |
| 3       | 32          | M   | 1                | FCCF 1.5 (ST) | Lattice with holes     | Inferior lattice without hole | -                           | -                            | -                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             |
| 4       | 23          | F   | 16               | FCCF 3, SN attached | IT retinal dialysis   | Demarcation lines superiorly | +                           | -                            | +                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             |
| 5       | 18          | M   | 28               | 6/36 2, inferior | IT dialysis of young  | Multiple demarcation lines, subretinal band | +                           | -                            | +                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             |
| 6       | 60          | M   | 16               | PL 4          | ST retinal break       | Lattice with holes     | Inferiorly bullous | +                          | -                            | -                             | +                             | +                           | +                           | +                           | +                           | +                             |
| 7       | 23          | F   | 52               | FCCF 3, SN attached | IT lattice with holes | Cystoid macular edema, temporal retinal macrocysts and preretinal neovascularizations | +                           | -                            | +                            | -                             | +                            | +                           | +                           | +                           | +                             |
| 8       | 57          | F   | 8                | FCCF 2, temporal RRD | ST horseshoe tear with rolled edge | Posterior vitreous detachment induced vitreous hemorrhage | +                           | -                            | +                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             |
| 9       | 15          | F   | 2                | 1/60 3.5, IN attached | Temporal lattice with holes | Temporal lattice with holes | +                           | -                            | +                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             |
| 10      | 15          | F   | 12               | 3/60 2, inferior | Temporal lattice with holes | Multiple demarcation lines, subretinal band | +                           | -                            | +                            | -                             | -                             | -                           | +                           | +                           | +                           | +                             |

+: 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.
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, intraocular inflammation, and intraocular/periocular infection. Optos has also been used to image RRDs before and after retinal reattachment surgery. Witmer and colleagues found that Optos autofluorescence may be helpful in documenting the demarcation of the extent of RRDs. 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. In a study on 50 cases of RRDs, Piccolino noted peripheral ischemia in 27 cases, most commonly in eyes with peripheral retinal holes. Minoda and Kanagami 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. The distance of the peripheral perfused vascular border from the optic disc was shorter in older individuals (≥60 years) compared to the younger subjects. Ophthalmoscopically, peripheral avascular area spans 0.5 disc diameters behind ora serrata, and angiographically, it is 1 mm wide. Kaneko and colleagues 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%). 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 co-authors. Other vascular causes of peripheral CNP were excluded from our series. The outer retinal ischemia consequent to the retinal detachment and increased resistance for vascular flow through the retinal vessels may also contribute to the exaggeration of a CNP. Chen and colleagues 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.

The amount of disc hyperfluorescence may probably be secondary to an element of uveitis induced by the retinal detachment. Also, the capillary dilatation and hyper-permeability may be related to an autoregulation process secondary to the hypoxia of outer retinal layers and resultant toxic metabolic products. Minoda and Kanagami reported that fellow eyes with attached retina also showed peripheral vascular obliteration, arteriovenous shunts, and vascular dilatation 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.

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.

References

1. Tripathy K, Sharma YR, Gogia V, Venkatesh P, Singh SK, Vohra R. Serial ultra wide field imaging for following up acute retinal necrosis cases. *Oman J Ophthalmol.*, 2015;8(1):71–72.
2. Sato K, Tsunakawa N, Inaba K, Yanagisawa Y. Fluorescein angiography on retinal detachment and lattice degeneration. I. Equatorial degeneration with idiopathic retinal detachment. *Nippon Ganka Gakkai Zasshi*. 1971;75:635–642 [Article in Japanese].
3. Sato K, Tsunakawa N, Yanagisawa Y. Fluorescein angiography on retinal detachment and lattice degeneration. II. Lattice degeneration with retinal detachment. *Nippon Ganka Gakkai Zasshi*. 1971;75(8):1873–1883 [Article in Japanese].
4. Cardillo Piccolino F. Vascular changes in rhegmatogenous retinal detachment. *Ophthalmologica*. 1983;186(1):17–24.
5. Tolentino FI, Lapas JV, Novalis G, Trempe CL, Gutow GS, Ahmad A. Fluorescein angiography of degenerative lesions of the peripheral fundus and rhegmatogenous retinal detachment. *Int Ophthalmol Clin.* 1976;16(1):13–29.
6. Tripathy K, Sharma YR, Ramananda K, et al. Recent advances in management of diabetic macular edema. *Curr Diabetes Rev*. 2015;11(2):79–97.
7. Tripathy K, Chawla R, Sharma YR, Gogia V. Ultrasound field fluorescein angiogram in a family with gyrate atrophy and Lovecoschisis. *Oman J Ophthalmol*. 2016;9(2):104–106.
8. Tripathy K, Sharma YR, Chawla R, Jain S, Behera A. Ultrasound wide-field imaging of an operated macular hole in gyrate atrophy. *J Ophthalmic Vis Res*. 2016;11(3):336–337.
9. Tripathy K, Chawla R, Mittal K, Temkar S. Egg yolk in the eye: an ultrawide-field examination. *BMJ Case Rep*. 2015;2016.
10. Tripathy K, Chawla R, Venkatesh P, Sharma YR, Vohra R. Ultrasound field imaging in uveitis non-dilating pupils. *J Ophthalmic Vis Res*. 2017;12(2):232–233.
11. Tripathy K, Chawla R, Mittal K, Farmania R, Venkatesh P, Gulati S. Ophthalmic examination as a means to diagnose Subacute Sclerosing Panencephalitis: an optical coherence tomography and ultrawide field imaging evaluation. *Eye Vis Lond Engl*. 2017;4:1.
12. Venkatesh P, Temkar S, Tripathy K, Chawla R. Intravascular antibiotic injection using 41G needle for the management of subretinal abscess in endogenous endophthalmitis. *Int J Retina Vit*. 2016;2:17.
13. Kumawat B, Tripathy K, Venkatesh P, Chawla R, Balodia S. Lacrimal abscess mimicking a choroidal mass: an ultrawide field examination. *Can J Ophthalmol J Can Ophthalmol*. 2016;51(3):e92–e94.
14. Anderson L, Friberg TR, Singh J. Ultrawide-angle retinal imaging and retinal detachment. *Semin Ophthalmol*. 2007;22(1):43–47.
15. Witmer MT, Cho M, Favaron G, Chan RV, D’Amico DJ, Kiss S. Ultrawide-field autofluorescence imaging in non-traumatic rhegmatogenous retinal detachment. *Invest Ophthalmol Vis Sci*. 2012;53(9):1209–1216.
16. Minoda K, Kanagami S. Fluorography of the fundus periphery with idiopathic retinal detachment. In: Laey JJD, ed. Symposium on Fluorescein Angiography Ghent 28 March 1976. Netherlands: Springer; 1976:573–581. Documenta Ophthalmologica Proceedings Series.
17. Singer M, Sugong M, van Hemert J, Kuehlewein L, Bell D, Sadda SR. Ultra-widefield imaging of the peripheral retinal vasculature. *Arch Ophthalmol Chic Ill 1960*. 1976;16:2318–2322.
18. Kaneko Y, Moriyama M, Hirahara S, Ogura Y, Ohno-Matsui K. Areas of nonperfusion in peripheral retina of eyes with pathologic myopia detected by ultra-widefield fluorescence angiography. *Investig Ophthalmol Vis Sci*. 2014;55(3):1432.
19. Chen SN, Hwang JF, Wu WC. Peripheral retinal vascular patterns in patients with rhegmatogenous retinal detachment in Taiwan. *Can J Ophthalmol*. 2016;11(2), e0149176.