

Review

# Ultra-wide-field imaging in diabetic retinopathy; an overview

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## Abstract

**Purpose:** To present an overview on ultra-wide-field imaging in diabetic retinopathy.

**Methods:** A comprehensive search of the pubmed database was performed using the search terms of “ultra-wide-field imaging”, “ultra-wide-field fluorescein angiography” and “diabetic retinopathy”. The relevant original articles were reviewed.

**Results:** New advances in ultra-wide-field imaging allow for precise measurements of the peripheral retinal lesions. A consistent finding amongst these articles was that ultra-wide-field imaging improved detection of peripheral lesion. There was discordance among the studies, however, on the correlation between peripheral diabetic lesions and diabetic macular edema.

**Conclusions:** Visualization of the peripheral retina using ultra-wide-field imaging improves diagnosis and classification of diabetic retinopathy. Additional studies are needed to better define the association of peripheral diabetic lesions with diabetic macular edema.

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**Keywords:** Ultra-wide-field imaging; Diabetic retinopathy; Diabetic macular edema; Fluorescein angiography

## Introduction

Since the introduction of human flash fundus photography in 1886, significant advances have occurred in the field of fundus imaging. Traditional fundus cameras take the images from the posterior pole (the macula and optic nerve), covering a 20–50 degree of field of view (Fig. 1). This part of fundus is the place for the most important ocular diseases including macular degeneration, glaucoma, and optic neuropathy. In addition, the images obtained from the optic nerve and

macula, have been routinely used for the diagnosis, management and follow up of retinal vascular occlusions and diabetic retinopathy. We present a brief review on the utility of the ultra-wide-field imaging in the management of diabetic retinopathy. The relevant articles were extracted following a comprehensive search of the pubmed database using the search terms; “ultra-wide-field imaging”, “ultra-wide-field fluorescein angiography” and “diabetic retinopathy”.

## Single-field versus wide-field imaging

Single-field fundus photography has been used to detect retinal and optic nerve disease whose primary site of involvement is the posterior pole. The advantages of single-field fundus photography are largely related to convenience to the patient, requiring less time, less light exposure, and in many cases no need for mydriasis. A report by the American Academy of Ophthalmology in 2004 noted that there is a sufficient level of evidence to suggest single-field fundus

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Fig. 1. Central/axial ultra-wide-field fluorescein angiography image obtained with Optos instrument from a patient with superotemporal branch retinal vein occlusion. Red circle shows a 30° image centered on the macula, the white line delineates the field covered by a montage of 7 field ETDRS image. With a central 30° and 7 field montage image, the areas of non-perfusion in the temporal periphery remain undetected.

photography as a screening tool for diabetic retinopathy to identify patients with retinopathy for referral for ophthalmic evaluation and management.<sup>1</sup> Non-mydriatic retinal photographs have been shown to allow easy, reliable and reproducible imaging of the optic nerve and retina in non-ophthalmologic settings such as the emergency department.<sup>2</sup>

Wide-field images can be obtained by three methods; creating montage images, using a special lens with a traditional fundus camera and using a specially-designed wide-angle camera. Montage image, that is a combination of 30-degree images, visualizes about 75 degrees of retina. Early Treatment Diabetic Retinopathy Study (ETDRS) group introduced the stereoscopic color fundus photography in 7 standard fields as the gold standard for the detection and classification of diabetic retinopathy.<sup>3</sup> Although 7-field photography is a reliable method for assessment of diabetic retinopathy, it is a time-consuming examination requiring skilled photographers and pharmacological pupil dilation. Consequently, other modalities including 2-field 45° retinal photographs (1 macular-centered field and 1 disc/nasal field), and non-mydriatic cameras were evaluated as user-friendly alternatives to standard 7-field imaging.<sup>4</sup>

Pomerantzeff developed the first wide-angle camera system, known as the Equator-Plus camera, in 1975. He used a contact lens and fiber optic scleral transillumination to take fundus images up to 148°. The Staurenghi lens is a contact lens system that provides a 5-fold increase (150°) in the fundus fields of view. Clarity Medical Systems introduced the Retcam contact imaging system that gives a maximum field of view of 130°. This technology utilizes a portable camera

with a fiberoptic cable light source connected to a computer and is particularly useful for the imaging of pediatric patients.

The Heidelberg Spectralis non-contact ultra-wide-field module offers a wide-field of view of 120° with a scanning laser ophthalmoscopy. Optos (Optos, Dunfermline, United Kingdom) introduced retinal imaging with non-contact scanning laser technology to take the ultra-wide field images. The 200° field of view of the Optos images covers 82% of the retinal surface (compared to 15% for the 45° images). A recent study comparing these two systems showed that on a single non-steered image, the Optos covers a significantly larger total retinal surface area. The Optos images show a wider view of the retina temporally and nasally, however, the Heidelberg Spectralis images show the superior and inferior retinal vasculature more peripherally and overall, the images from Spectralis system seemed to have less peripheral distortion.<sup>6</sup> These initial comparative studies were performed using the Optos 200Tx and not with the newer Optos California device which purports to provide better visualization of the inferior and superior periphery as well as new software for stereographic projection to address peripheral distortion.

#### Ultra-wide-field versus montage ultra-wide-field imaging

Despite a wide field of view achieved by the Optos optomap images, a small but important part of the peripheral retina may be obscured in the axial images, particularly in the vertical meridian as noted previously. This may be due to the inherent limitation in the imaging of the peripheral retina, obscuration by the lids or pupil, or a combination thereof. Consequently, Optos developed a special software to combine the axial images with those obtained with steering to different gazes. This montage image covers the entire field of the retina (Fig. 2). Using this software, Singer et al<sup>7</sup> evaluated the extent of the peripheral retinal vasculature in normal fluorescein angiography (FA) images and provided the normative data as a potential reference for future studies. They found significant difference in distance from the optic disc to the periphery based on the quadrant (with temporal being larger than inferior being larger than superior being larger than nasal) and age (shorter in older individuals). The stereographic projection software is also able to address the problem of the peripheral non-linear warp and difference in the size of the measurements in relation to the angle of view. Thus, the lesion areas can be calculated in anatomically correct physical units.<sup>8</sup>

#### Ultra-wide-field imaging in diabetic retinopathy

Visualization of the peripheral retina using ultra-wide-field imaging has led to new era in the assessment of diabetic retinopathy. Several studies evaluated the utility of the ultra-wide-field imaging in grading diabetic retinopathy. Price et al<sup>9</sup> compared diabetic retinopathy severity grading between Optomap ultra-wide-field images and an ETDRS seven-standard field view. Although severity grades were identical in 85% of the images and within one severity level in 100% of

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