ACTA SCIENTIFIC CLINICAL CASE REPORTS

Volume 6 Issue 8 August 2025

Editorial

# Imaging in Ophthalmology

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**Received:** July 24, 2025

**Published:** July 30, 2025



Ophthalmic imaging not only enables clinicians to record their clinical findings in an objective and reproducible manner, but also helps to identify subtle clinical features not visible with standard examination techniques and allows quantitative examination with specialised tools. Over the years, the field of ophthalmic imaging has advanced by leaps and bounds and this editorial is an overview of the current available technologies.

## Retinal imaging

Colour fundus photography utilises a camera system to acquire a photo of the human retina up to 30 to 45 degrees (conventional cameras). Ultra-wide field cameras are now available which help visualise up to the retinal periphery beyond the vortex veins. They are vital for diagnosis and monitoring of most posterior segment pathologies. Some of these camera systems also come with inbuilt capabilities such as fundus fluorescein angiography (FFA), indocyanine green angiography (ICGA) or fundus autofluorescence (FAF). More recently, cameras are being used for diabetic eye screening and virtual clinics too.

Scanning laser ophthalmoscopy (SLO) devices are similar to fundus cameras but use a scanning laser beam of a particular wavelength (instead of camera flash) to illuminate and visualise a given area of the retina. By utilising specific filters, long and short wavelengths of light can be used to visualise subretinal (e.g. drusen and neovascularisation in age-related macular degeneration) and superficial retinal structures (e.g. epiretinal membrane in various vitreo-retinal diseases) respectively.

FAF images can be obtained by any of the above devices by using blue or green light filter, which highlights lipofuscin pigment, or infra-red light filter which highlights melanin. They help image structures which have innate fluorescent properties (e.g. drusen). Similarly, FFA is used to visualise the retinal vasculature following intravenous injection of a fluorescent contrast agent and utilising blue excitation and yellow-green barrier filters. This is of tremendous value in diseases such as diabetic retinopathy, retinal vein occlusions, choroidal neovascularisation, central serous chorioretinopathy and posterior uveitis. ICGA is mostly limited to imaging of choroidal vasculopathies.

Optical Coherence Tomography (OCT) is a non-invasive technique which provides high-resolution images of the retina. It is based on the principle of interferometry and utilises light waves of wavelengths from 810 to 1054 nm. It obtains light interference patterns based on the retinal tissue depth and converts these light signals into colour or grayscale images of the retinal cross-section. It is very useful to evaluate vitreoretinal interface diseases, macular edema as well as outer retinal diseases. The newer Enhanced Depth Imaging (EDI-OCT) and Swept-Source (SS-OCT) OCT systems even allow visualisation up to posterior border of the choroid.

Optical Coherence Tomography Angiography (OCTA) is a non-invasive method to map the retinal and choroidal vasculature in high resolution, without having to inject intravenous contrast. It is widely used in detection of choroidal neovascularisation in wet age-related macular degeneration and areas of non-perfusion which are not clinically visible.

### Optic nerve head and peripapillary imaging

Optic disc photography is useful for glaucoma imaging and can be performed using any commercially available fundus camera systems. Its clinical importance lies in serial follow-up of chronic glaucoma patients. Utilising SLO devices, we can get topographic as well as cross-sectional images of the optic nerve head for detailed measurements like optic disc and cup area.

OCT of the optic nerve and peripapillary retina enables measurement of the retinal nerve fibre layer (RNFL) thickness and compares it with a normative database to assess the likelihood of glaucoma or monitor its progression. Similarly, ganglion cell complex measurements at the macula can be done.

Imaging systems and OCT systems are marketed by commercial platforms such as Heidelberg Engineering, Zeiss, Topcon and Nidek.

### External, oculoplastic and adnexal imaging

Serial photography and/or videography of adnexal pathology and eye movements should be a standardised procedure as it is required to record surgical outcomes.

Ocular and Orbital Ultrasound is a useful method of imaging in diagnosis of tumours and posterior segment evaluation in eyes with opaque media. Ultrasound involves 2 types of scans. The 'A' scan uses a transducer of 10 MHz frequency and obtains axial scans of the eyeball whereas 'B' scan obtains cross sectional images of the eye and orbit by combining several A scans and generates a 'real-time' image of the eye during movements. Doppler flow imaging of orbital circulation is useful in cases of carotico-cavernous fistula.

Ultrasound bio-microscopy (UBM) uses a higher frequency scanner (35MHz-100MHz) and is useful in examination of the anterior few millimetres of the globe. Higher frequencies combined with shorter pulses in UBM enables detailed examination of pigmented tumours such as ciliary body melanoma.

### Anterior segment imaging

Corneal topography involves measurement of the corneal surface architecture and is based on the Placido-disc principle. With newer technologies such as scanning slit and Schiempflug principle, even the posterior surface of the cornea and its entire thickness can be visualised and measured. Some commercially available systems include the Orbscan (Bausch and Lomb) and Pentacam (Oculus). These devices find application in corneal diseases such as keratoconus and refractive surgeries. More recently, ocular wavefront analysis systems are being used for the same.

In confocal microscopy, microscopic two-dimensional in-vivo images of the cornea can be obtained at various depths. It is based on laser scanning principle and is used in infectious keratitis, especially to detect fungal elements and Acanthameba cysts.

Corneal and anterior segment OCT is similar to posterior segment OCT but uses longer wavelengths of light. It can be used for visualisation of the anterior chamber angle in glaucoma assessment and in planning of corneal transplant procedures. it can be used post-surgery to evaluate corneal graft thickness and LASIK-flap thickness.

More and more techniques are evolving as we read this editorial. Some of the above-mentioned imaging systems have acquired artificial intelligence (AI) systems. These AI-powered algorithms and tools are now enabling early diagnosis of common vision-threatening conditions like diabetic retinopathy, age-related macular degeneration and glaucoma.