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OPTICAL COHERENCE TOMOGRAPHY

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2016 — 25 YEARS OF OPTICAL COHERENCE TOMOGRAPHY

It was first described by Huang and colleagues in 1991.


Ophthalmic applications have developed the earliest research.

It is estimated that there are now ~30 million OCT imaging procedures performed worldwide every year.

OCT UTILIZES A CONCEPT KNOWN AS INTERFEROMETRY

OCT works by projecting a broadband light into the eye.
- Most systems centered around 840 nm wavelength.
- Backscattered light is combined for comparison with light reflected from a reference arm.
- The combination of both lights generates an interference signal.
- The interference patterns are processed to form the cross-sectional images of the retina.

APPLICATIONS FOR OCT

Skin
Major vessels
Heart

THE FIRST AND MOST EXTENSIVE USE — THE EYE

Cornea
Iridocorneal angle
Retina
Choroid
Optic nerve

THE PRIMARY USE IN THE EYE - RETINA

Shows retinal architecture
- Differentiation of retinal layers
- Choroid
- Foveal shape
- Vitreous
- Used extensively in the diagnosis of Glaucoma
- Vitreoretinal disorders
Comparative histological section of the fovea of a normal human eye

Aquisition of a series of OCT scans

Three-dimensional images

Three-dimensional movies

Segmentation of the RNFL layer

Glaucoma

Optic neuritis

Erthocyte motion detection -- SSADA algorithm

Split-spectrum amplitude decorrelation angiography

Detection of differences in B-scans

Scans in the same location

Scans in short intervals

http://vsri.ucdavis.edu/research/retinal/oct
OCT ANGIOGRAPHY

Visualization of vessels
- retina
- superficial capillary plexus
- deep capillary plexus
- choroid
- optic nerve

Method:
- fast
- non-invasive

CRASH COURSE IN RETINA FOR NEONATOLOGISTS

OCT interpretation

RETINAL DETACHMENT

Normal

Pathology

Vitreomacular Traction

Normal

Pathology

Cystoid Macular Edema (Intraretinal Cysts)

Normal

Pathology
EPIRETINAL FIBROSIS

Normal
Pathology

MACULAR HOLE

Normal
Pathology

LAMELLAR MACULAR HOLE

Normal
Pathology

MACULAR DETACHMENT

Normal
Pathology

HARD EXUDATES (VASCULAR ACTIVITY)

Normal
Pathology

NORMAL ADULT VS INFANT MACULAR OCT

Thick inner retinal layers of the infant
- Centrifugal migration

Thin outer retinal layers in premature infants
- Centripetal growth

External limiting membrane (ELM), IS/OS and OS/RPE are not present in premature fovea

TWO-DIMENSIONAL AND THREE-DIMENSIONAL IMAGES


COMMERCIAL TRANSPARENT PORTABLE SDOCT SYSTEMS USEFUL FOR SUPINE IMAGING

(A) Bro∧turn Retina system, 0.9 kg (2-pound) handheld scanner

(B) Optovue iStand system with a 2.3 kg (5-pound) head scanner

EXAMINATION TECHNIQUE

Technique seems to be without discomfort for the infant
No lid speculum necessary
No bright illumination
Silent movements, dripping and camera movements
24% sucrose solution (Toot Sweet, Hawaii Medical, Pembroke, MA)


CURRENT SYSTEMS COVER TYPICALLY ZONE I

APPLICATION OF OCT IN NICU

PHOTORECEPTOR DEVELOPMENT

Three-dimensional maps of human foveae from 31–43 weeks PMA

MACULAR EDEMA
OF PREMATURITY

- a unique representation of cystoid macular edema (CME)
- the macular edema is:
  - Bilateral
  - Symmetric
  - isolated to the inner nuclear layer
  - typically causes foveal bulging with elongation of hyperreflective septae


RETINAL VASCULATURE

OCT as an effective tool to characterize the retinal vasculature

Vascular Abnormality Score by OCT (VASO) to quantify abnormalities graded on OCT such as:
- vessel elevation
- hyporeflective vessels
- scalloping of retinal layers
- perivascular spaces


CASE 1 (TOTH ET AL.)

650-g, 23-week postmenstrual age (PMA)
received confluent laser to both eyes at 32 weeks PMA
The patient had aggressive posterior ROP, zone I with severely immature retinal development and plus disease
- preretinal structures traced in red
- Green arrow indicates retinal detachment
- Retcam fundus photograph demonstrates tractional retinal detachment 1 month after SD OCT imaging

CASE 2 (TOTH ET AL.)

A former 730-g, 24-week PMA, male infant was referred for diode laser treatment of both eyes at 38 weeks
Indirect ophthalmoscopy demonstrated 4 quadrants of plus disease in both eyes, stage 4A in the right eye
- Cross-sectional spectral domain optical coherence tomography (SD-OCT) image shows retinal detachment (green arrow) and subclinical retinoschisis

CASE 3 (TOTH ET AL.)

A former 650-g, 23-week PMA, Caucasian male was evaluated for progressive ROP despite laser photocoagulation in both eyes
- thick membranes complexes over the macula creating prominent retinal folds, and tractional retinal detachment
CASE 3 (TOTH ET AL.)

At 37 weeks PMA, he had lens sparing vitrectomy in the left eye for a stage 4A detachment.
- Patient’s left eye 4 days after vitrectomy surgery.
- Cross-sectional spectral domain optical coherence tomography (SD-OCT) image demonstrates retinal detachment (green arrow) and retinoschisis (brown arrow).

TAKE HOME MESSAGES

Fundus examination with indirect ophthalmoscopy remains the gold standard for monitoring patients with ROP.

SD-OCT can evaluate subclinical pathology with:
- Retinopathy
- Retinal detachment in patients with retinopathy ROP
- Retinal cyst
- Vitreoretinal traction

It can serve to monitor:
- Macular development
- Resolution of macular edema of prematurity
- Vascular activity (VASO)
- Progression of retinal detachment into the macula
- Stage 4A
- Stage 4B