Swept-Source OCT of Cortical Vitreous & Retina

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OCT: 1998 - Present
P Stanga, S Downes, A Bird et al.
Comparison of optical coherence tomography and fluorescein angiography in assessing macular edema in retinal dystrophies: preliminary results.
*Int Ophthalmol.* 2001;23(4-6):321-5

**CONCLUSIONS**

- OCT is as least as sensitive as FFA for identifying oedema
- OCT is a useful tool in assessing response to oral acetazolamide by comparative measurements of retinal thickness
TOPCON launches the first commercial Fourier Domain OCT

and we can now individualize new tissue landmarks…
Evolution of OCT: 15 years after FD $\rightarrow$ Swept Source

- **Scan Speed** (A scans/second)
  - 400
  - 27,000
  - 100,000

- **Time Domain**
- **Spectral Domain**
- **Swept Source**
Swept-Source DRI-OCT 1 Atlantis®: Why is better that the others?

Advantages by Swept-source

• **2x faster** imaging speed (100,000 A-line/s)

• **Uniform** image quality

• **Improved vitreous visualization**

Advantages by longer wavelength (1,050nm)

• **Increased tissue penetration** and visibility of the choroid and sclera

• **Invisible** scanning light reduces eye movement

• **Reduced intra-tissular light scattering**

Observation & photographying of fundus

• **Longer scans:** 12mm + 43 picture angle
Introduced SS-OCT into Clinical Practice (UK), 2012
Vitreoretinal Assessment SS-OCT in 2014

- Improved imaging of the cortical vitreous and the vitreoretinal interface
- Achieve better understanding of retinal pathological changes
- Assessment of choroidal thickness

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SS-OCT vs TD OCT: Vitreoretinal interface
SS-OCT vs TD OCT: Vitreoretinal interface
SS-OCT: Superior Cortical Vitreous Visualization?

- Weakly scattering (almost transparent)
- Not stable over the time (movement)

Benefit of swept-Source OCT

Less sensitive to the sample motion

2x faster imaging speed (100kHz) compared to OCT-2000 (50kHz)
In-vivo Imaging and Measurement of the Bursa Premaculais using 1,050nm Swept-Source Deep Range Imaging Optical Coherence Tomography (DRI-OCT1 Atlantis®)

S Caputo1,2, A Sala-Puigdollers1,2, SJ Charles1, S Biswas1, DB Henson1,2,3, D McLeod1,2,3, PE Stanga1,2,3

1Manchester Royal Eye Hospital, UK, 2Manchester Vision Regeneration (MVR) Lab, UK, 3Manchester Academic Health Science Centre and Centre for Ophthalmology and Vision Research, Institute of Human Development.

**Purpose:**
To image in-vivo the posterior cortical vitreous, the Bursa Premaculais (BPM) and Space of Muntz (SM), and to measure the BPM using the new 1,050nm Swept-Source Deep Range Imaging Optical Coherence Tomography (DRI-OCT1 Atlantis®).

**Methods:**
Pilot and retrospective cross-sectional study.
One-Hundred nineteen (119) consecutive patients (age range 5 to 100 years) underwent DRI-OCT1 Atlantis.

Using a 5-line cross pattern centered on the fovea, the detection or non-detection of a BPM and/or SM and the stage (0-5) of posterior vitreous detachment (PVD) was determined in each eye.

Single-Line 12mm long horizontal scans were used for measurement purposes; the horizontal (width) dimension of the BPM, and its anteroposterior (depth) dimension at the deepest foveal point, were recorded.

**Results:**
A BPM was detected in 57.1% (136/238) of eyes (including in the 5 year old patient and the centenarian). The BPM and SM coexisted in 97.8% (133/136).

The distribution of PVD in the 238 eyes was 47%, 1.7%, 9.7%, 10.5%, 5% and 25.6% in stages 0 to 5 respectively. Prevalence of BPM was 84.3% (119/140 eyes) in PVD stages 0, 1 and 2 combined; 52% (132/252 eyes) in stage 3; 25% (3/12 eyes) in stage 4. The BPM was detected in 4.9% (3/61) of eyes with a non-gradable PVD.

The prevalence of detected BPM is 75.4% in the patient group age 0-60 and 38% in the group age 60-100.

Of 65 patients with PVD stage 0-2 a BPM was identified bilaterally in 52 patients (80%) and only unilaterally in 4 patients (6%). The remaining patients showed a bilateral absence of a BPM (14%).

The dimension of width and depth of the BPM could be accurately measured in 94 of the 136 eyes.

Mean width was 7.00 μm (range: 3.39–10.13 μm, SD: 4.12 μm) and mean depth was 4.69 μm (range: 3.11–18 μm, SD: 18.7 μm). Width and depth of the BPM did not correlate with age (R²/Width=0.0016, R²/Depth=0.0186).

Bilateral BPM tended to be symmetrical in width but less so in depth (R²/Width=0.63, p=0.001, R²/Depth=0.33, p=0.001).

**Conclusions:**
We present the results of the first study of the cortical vitreous employing Swept-Source 100,000 A-line scans/sec, 1050nm wavelength and 12 mm long scans.

Our cohort of patients included a wide range of ages: the youngest and oldest patients in whom the cortical vitreous has been assessed in-vivo using OCT technology. The BPM and SM can be imaged in patients from as early as the first to as late as the tenth decade of life.

Swept-Source OCT technology allows for improved and uniform image quality in the same image from the cortical vitreous to the anterior surface of the lens. This new OCT technology allows for improved in-vivo anatomical characterisation of the BPM and, for the first time, demonstration of a positive correlation between the presence of BPM and SM.

Further prospective studies are required to better understand the role of the BPM and SM in different eye conditions and perhaps their influence on the response to intravitreal therapies.

**Financial Disclosures:**

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In-vivo Imaging of Cortical Vitreous using 1,050nm Swept-Source Deep Range Imaging Optical Coherence Tomography (DRI-OCT1 Atlantis®)

Paulo E. Stanga, Anna Sala-Puigdollers, Silvestro Caputo, Hojr Jaberansari, Monica Cien, Jane Gray, Yvonne D’Souza, Stephen J Charles, Susmito Biswas, David B Henson, David McLeod

Am J Ophthalmol. 2014 Feb;157(2)
Purpose

- To image *in-vivo* the posterior cortical vitreous, the Bursa Premacularis (BPM) and Space of Martegiani (SM), and to measure the BPM using a new 1,050nm Swept-Source optical coherence tomography (OCT) scanner (Topcon® Deep Range Imaging, DRI-OCT1 Atlantis®)
- Pilot and retrospective study
BPM + SM in 5 years old

PVD STAGES ON DRI-OCT
Bilateral BPM + SM in 100 years old
PVD STAGES ON DRI-OCT

**PVD Stage 1:** Focal preifoveal PVD, limited to either the temporal or nasal side of the fovea

**PVD Stage 2:** Involving the nasal and temporal side of the fovea with foveal attachment of the central vitreous
PVD STAGES ON DRI-OCT

**PVD Stage 3**: Optic nerve head cortical vitreous attachment only

**PVD Stage 4**: complete PVD over the macula and optic nerve head
PERCENTAGE OF EYES CLASSIFIED PER GROUP AND SHOWING THE PREVALENCE OF BPM
Conclusions

• Imaging the cortical vitreous employing Swept-Source 100,000 A-line scans/sec, 1050nm wavelength and 12 mm long scans is feasible

• Our cohort of patients included a wide range of ages: the youngest and oldest patients in whom the cortical vitreous has been assessed in-vivo using OCT technology

• BPM and SM can be imaged in patients from as early as the first to as late as the tenth decade of life
Conclusions

• Swept-Source OCT technology allows for improved and uniform image quality in the same image from the cortical vitreous to the anterior surface of the sclera

• This new OCT technique allows for improved in-vivo anatomical characterisation of the BPM and, for the first time, demonstration of a positive correlation between the presence of BPM and SM

• Further prospective studies are required to understand better the role of the BPM and SM in different eye conditions
With a significant number of therapies being delivered via intravitreal injections, it is becoming increasingly important to being able to image and understand pre and post treatment anatomical changes *in-vivo* not only at the level of the subretinal space-choroid complex but also at that of the vitreoretinal interface and cortical vitreous.
5-year-old girl

ERM formation in conjunction with Bursa Premacularis
SS-OCT : Vitreoschisis

NVE & Vitreoschisis & TRS

Vitreoretinal Assessment SS-OCT in 2014

- Improved imaging of the cortical vitreous and the vitreoretinal interface
- Achieve better understanding of retinal pathological changes
- Assessment of choroidal thickness
SS-OCT vs TD OCT: Retinal pathology
SS-OCT evaluation of Retinal Cavernous Haemangioma

- Good penetration through haemorrhage
- Measure volume of each blood cavern and its wall thickness
- Follow-up
- Assessment of response to therapy
Sweep-Source Optical Coherence Tomography of Retinal Cavernous Hemangioma: a New Diagnostic Imaging Gold Standard?

S Pastor-Idueate, M Gil-Martinez, Nicolas Crim, C Quijano, B Biswas, S Charles, P McLeod, PE Stanga

Introduction:
Cavernous Retinal Haemangioma (CRH) is a rare vascular retinal hamartoma which can present either sporadically or as a dominantly inherited trait. CRH can induce acute visual loss when associated with vitreous haemorrhage, which can be recurrent. Swept-Source Optical Coherence Tomography (SS-OCT) has higher tissue penetration than Fourier-Domain OCT due to the utilisation of longer-wavelength (1,050nm).

Purpose:
To report on a new, non-invasive imaging method for the diagnosis and management of CRH.

Methods:
A macula-clumping retinal haemorrhage of 6 months duration in a 6 year-old patient was imaged with SS-OCT (Topcon DRI OCT-1 Atlantis, Topcon Corp, Japan) and Fourier-Domain (FD-OCT) (Topcon 3D OCT-2000, Topcon Medical Systems, Oakland, New Jersey, USA) Optical Coherence Tomography (OCT) and Wide-Field Fundus Fluorescein Angiography (FFA) (Retcam 5, Clarity Medical Systems Inc., Pleasanton CA, USA).

Results:
FD-OCT showed an intraretinal lesion with cystic-like internal appearance. Significant optical shadowing was present and prevented reaching a diagnosis. However, SS-OCT showed an intra-retinal lesion consisting of a group of grape-like cystic formations with an overlying epiretinal membrane-like tissue forming bridges between them. There was no choroidal extension of the lesion. FFA confirmed the diagnosis of CRH. The dimensions of the individual vascular structures and thickness of the vascular walls could be determined.

Conclusions:
SS-OCT was superior to FD-OCT in showing the internal anatomy of the CRH, the intra-retinal only location of the lesion as well as the presence of an associated epiretinal tissue compatible with the internal limiting membrane (ILM). SS-OCT can assist in the diagnosis of CRH by allowing for a more accurate anatomical characterisation of CRH, especially in those cases with presence of intra and sub-retinal haemorrhage.

This is the first report of the SS-OCT findings in CRH. SS-OCT may allow non-invasive and more accurate monitoring of the natural evolution or response to treatment, perhaps becoming the new imaging gold standard for Cavernous Retinal Haemangioma.
SS-OCT in Optic Disc Pit (ODP) Maculopathy – helpful in surgery approach.

Vitreoretinal Assessment SS-OCT in 2014

- Improved imaging of the cortical vitreous and the vitreoretinal interface
- Achieve better understanding of retinal pathological changes
- Assessment of choroidal thickness
SS-OCT: Imaging audit tool
Measuring Choroidal Thickness
**Swept-Source Optical Coherence Tomography (1,050nm DRI-OCT1 Atlantis®) Assessment of the Cortical Vitreous and Choroidal Thickness in Different Macular Disorders**

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**Purpose:**
Swept-Source Optical Coherence Tomography (SS-OCT) determination of the prevalence of the Bursa Premacularis (BPM) and Space of Martegianii (SM) and assessment of Choroidal Thickness (CT) in healthy eyes (HE) and eyes with various macular disorders (MD).

**Methods:**
Retrospective, comparative and non-interventional study, 124 non-consecutive patients underwent 1,050nm SS-OCT (DRI-OCT1 Atlantis®, Topcon Corp, Japan). The prevalence of the BPM and SM was assessed in HE and MD. Macular CT was determined by measuring the distance between the RPE and the choroid/sclera junction at seven measurements (one subfoveal, three further determinations every 300μm up to 1500μm temporal (T1, T2, T3) and nasal (N1, N2, N3) to fovea of 54 HE and 150 MD. Patients were categorised into 8 groups: Diabetic Retinopathy (53), Age-Related Macular Degeneration (AMD) (37), High Myopia (HM) (22), Vitreomacular Adhesion (VMA) and Epiretinal Membrane (ERM) (11), Central Serous Retinopathy (CSR) (13), Retinitis Pigmentosa (RP) (9) and Miscellaneous (10).

**Results:**
Mean age was 47±23 years for HE versus 57±22 years for MD (p=0.05 Student’s t-test). Mean sub-foveal CT was 280±75 μm for HE versus 223±84 μm for MD (p=0.009 Student’s t-test). BPM was detected in 30 (60.7%) of HE; CI [0.44-0.78] versus 51 (34.0%) of MD; CI [0.27-0.41]; p=0.001 Fisher’s exact test. SM was present in 30 (55.6%) of HE; CI [0.42-0.68] versus 49 (32.7%) of MD (p=0.004 Fisher’s test).

Sub-group analysis showed significant differences in CT between HE and MD with Diabetic Retinopathy, AMD, HM, CSR and VMA and/or ERM (p<0.05 U Mann Whitney). BPM and SM analysis showed significant differences in between HE and MD with Diabetic Retinopathy, AMD, HM and VMA and/or ERM (p<0.05 Fisher’s test).

**Conclusions:**
HE group’s values showed data comparable to previous studies in mean age and subfoveal CT. The overall prevalence of BPM and SM detected in HE was also comparable to values reported in previous studies. However, we have found that macular CT is higher in the HE group compared to the MD one. In addition, we have also observed variability in the location of the reading of the highest CT in eyes with different MD. CT and regional variations in thickness could play a role in the pathogenesis of some ocular conditions as has been previously reported. We have found the BPM and SM to be more prevalent in the HE group. Further studies are required to understand better the role of the BPM and SM in these different eye conditions and perhaps their influence on the response to intravitreal therapies.
Anatomical And Functional Outcomes in X-Linked Retinoschisis Treated With Topical Carbonic Anhydrase Inhibitor - Dorzolamide

C Quijano, S Pastor-Idoate, M Gil-Martinez, S Biswas, P Stanga

Infra-red wavelength (1,050 nm) + high speed scanning (100,000 A-scans/sec):
- allows deeper penetration into choroid and sclera with uniform signal sensitivity from the vitreous up to the chorioscleral interface
- less light scattering improves results in eyes with cataracts
- provides uniform sensitivity allowing superior visualization of the vitreous and choroid and more data to be collected in same scan

12mm x 9 mm wide scan captures the macula and disc in the same scan
Advanced 3D volumetric layer detection algorithms
Less sensitive to sample motion
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