Spectral-Domain OCT: A Quantum Leap for Retinal Imaging

Optical coherence tomography (OCT) has revolutionised the imaging of the vitreoretinal interface, intraretinal and even subretinal structures. It allows non-invasive in-vivo analysis of these structures, giving us insight into the pathophysiological processes of vitreoretinal disorders e.g. vitreomacular traction.

The traditional OCT like the Stratus is based on a time-domain (TD) OCT technology, which produces images based on the phase differences between waves returning from a reference path, and the delayed waves returning from an intraocular path.

The new generation spectral-domain (SD) OCT produces images by analysing waves returning from the intraocular path in a spectrometer using a mathematical technique (Fourier transform) and then comparing it with the reference waves. The SD-OCT is thus also known as the Fourier Domain (FD) OCT.

SD-OCT systems include the CIRRUS OCT by Carl Zeiss Meditec, Topcon’s SOCT (3D-OCT-1000), RTVue-100 (Optovue), Copernicus (Optpol), Spectral OCT/SLO (OTI) and the Spectrals by Heidelberg Engineering GmbH.

Retinal specialists at NHG Eye Institute @ TTSH are in the process of evaluating the cirrus SD-OCT system.

Advantages of the SD-OCT

One of the main advantages of the SD-OCT is the increased speed of data acquisition. For example, the Cirrus is capable of making 27,000 A-scans second, which is about 50 times that of a TD-OCT like the Stratus. High speed reduces scan times, which in turn reduces the dependency on consistent fixation. The averaging of a greater number of images reduces noise and other artifacts. Ultimately, significantly better image quality is achieved. (Fig 1)

The greater speed also allows for greater sampling density. This increases sensitivity and decreases sampling error, allowing for improved imaging of smaller lesions in addition to better resolution of larger structures.

The great number of scans done per unit time also allows SD-OCT systems to generate three-dimensional reconstructions, which can be further manipulated. Three-dimensional images can be collapsed into a 2-dimensional plane, realigned to capture specific lesions, or cubed to calculate volume. Furthermore, many SD-OCT systems also allow for a fundus image to be overlaid with the macular thickness map for location of specific lesions. (Fig 2)
Dear Reader,

Welcome to FOCUS, the bi-monthly newsletter of the NHG Eye Institute. Our new name and logo reflect a similar change in primary eye care. All this, even as we maintain our focus on primary eye care, with the occasional nod to ophthalmic sub-specialists.

In this issue, we provide updates on the blade-free Intralase technique for LASIK, and also describe how interpreting refractive information into cataract surgery has taken our bread & butter procedure to its next level.

Finally, our editorial pulls out highlights: a wonderfully neglected reason to give up smoking - blindness from age-related macular degeneration.

I trust you will continue to find pleasure in this magazine, whatever the name. We are already looking forward to bringing you the next issue, which will focus on Glaucoma and Neuro-ophthalmology.

Dr Wong Hon Tym (Chief Editor)

FOCUS Editorial Team

Dr VonHon Tym (Chief Editor)
Ms Tan Mui Leng (Secretary)
A/Prof Goh Lee Gan (Advisor)

NHG Eye Institute

VITREO-RETINA

The Amslider Chart – A simple test for central vision

Introduction

The retina lines the circular area of the retina enclosed within the main vascular arcades. The fovea is located at the centre of the macula. It houses the highest density of cone and rod photoreceptors which are responsible for high resolution central vision essential for activities such as reading and driving.

A qualitative assessment of the macula can be made using the Amssler chart, developed originally by Marc Amssler. This test enables one to detect scotomas and metamorphopsia in the central visual field.

The Amssler chart can be used as a screening tool in those at risk of:

- Choroidal neovascularisation, such as highly myopic individuals
- Progression from atrophic (dry) age-related macular degeneration to the exudative (wet) form
- Retina oedema as a result of retinal vascular disease
- Toec maculopacy - in patients using certain medication

Amsler Chart

The chart is available as a booklet of seven square grids with a central fixation spot.

When used at the designated testing distance of 28-30cm, each grid subtends an angle of 20 degrees at the eye. The patient’s refractive error must be fully corrected for this distance. This test should be conducted monocularly prior to any mydriatic fundus examination and the chart should be evenly well-illuminated.

Using the Amsler

The patient is asked to fixate on the central spot, while observing the entire chart detail. The practitioner then poses five questions:

- While keeping your gaze on the central spot, can you see all the horizontal and vertical lines straight and with all squares of equal size?
- Are there any holes, spots or blurry areas?
- Can you see the white spot at the centre of the grid? This tests for the presence of a central scotoma.
- While keeping your gaze on the central spot, can you see all four corners of the square? Accurate scotomata in chorioretinal Glaucoma manifest as loss of the temporal corner of the chart; similarly nasal step type scotomas can result in loss of the nasal aspect of the chart. Such scotomas, in which all four corners of the chart are absent, can be observed in advanced Glaucoma and retinal detachment.
- Are there any rings or arcs around a clear centre?

This identifies scotomas in the area surrounding the fixation point.

• Are all the horizontal and vertical lines straight and parallel, with all squares of equal size?

Distortion of the grid lines is known as ‘metamorphopsia’. ‘Macropsia’ is a decrease in image size which may occur, for example, in macular oedema, while ‘micropsia’ is an increase in image size which may occur when cones are compressed together such as in some tumours.

Conclusion

The Amssler chart provides a quick, portable and inexpensive assessment of the macular function. However, it is neither 100 per cent sensitive or specific. Very early or small defects cannot be detected on the conventional grid.

By A/Prof Au Eong Kah Guan & Dr Lekka Gopal, NHG Eye Institute @ AH

SPOTLIGHT ON

NHG Eye Institute’s Vitreo-Retina Team

NHG Eye Institute’s VR Team is proudly distinguished by a cache of firsts: the use of scanning laser ophthalmoscopy to dynamically image in lesion-related macular degeneration; sutureless 23G vitrectomy; the use of intra-vitreal steroids in the treatment of refractory macular edema; and the use of low-cost intravitreal Ganciclovir therapy for infectious retinitis in AIDS patients.
SMOKING AND BLINDNESS in Age-Related Macular Degeneration

A CIGARETTE A DAY KEEPS YOUR VISION AWAY

Can smoking really cause blindness?
Yes, smoking can cause blindness. The more or longer you smoke, the greater the risk.

There are thousands of dangerous toxins in cigarettes smoke that can harm the tissues in your eye, damaging them permanently. Refer to Fig. 1 for these toxins.

Smoking can lead to Age-Related Macular Degeneration (AMD), one of the most common causes of permanent blindness in the world.

What is Age-Related Macular Degeneration (AMD)?
AMD is a disease that affects the part of the eye called the macula (at the back of the eye). The macula is the most sensitive part of the retina. It is important for clear vision and allows you to see fine details.

A qualitative assessment of the macula can be made using the Amsler chart developed originally by Marc Amsler. This test enables one to detect defects and distortion in the central visual field.

Symptoms of AMD are:
• Blurred vision – dimming in the central vision
• Distorted vision – straight lines appear wavy
• Dark or empty areas in the centre of your vision

Many cases of AMD are irreversible and difficult to treat.

How does smoking cause AMD?
Smoking is currently the only lifestyle habit proven to cause AMD. Smoking reduces blood flow and antioxidants needed by the eye to stay healthy, increasing your risk of AMD. If you smoke, you are 2-4 times more likely to develop AMD compared to non-smokers.

Even if you are as young as 55 years old, you can get AMD and lose your eyesight.

Quit smoking today and preserve your eyesight!
Ask your optometrist for help to quit or call QuitLine 1800 438 2000

This article and pictures are contributed by Health Promotion Board Singapore
Refractive Surgery

Advances in Refractive Surgery: “Blade” versus “Bladeless” LASIK

LASIK with microkeratomes has been performed safely in millions of cases for more than 15 years. The introduction of the femtosecond laser for flap creation in 1999 radically changed the scene of LASIK surgery. Often marketed as the “bladeless” or “all-laser” way of performing LASIK, it involved a strong layer of hype at the time. The laser requires precise targeting at the corneal stroma, as well as ocular alignment, and considerable ocular lubrication. Lasers are also expensive. Patients have expressed concerns about pain and an increase in the operating time. However, today, microkeratome LASIK is not considered to be outdated. While the concern over the safety and efficacy of the procedure remains, it appears that the femtosecond laser is not the absolute right choice for every patient. In many cases, microkeratome LASIK can deliver superior patient outcomes, which is the reason why it is still considered the gold standard.

Another advantage of Intralase is that no fluid is introduced onto the stromal bed under the flap during flaps cutting. This ensures that the stromal hydration state is uniform across the whole corneal bed, thus avoiding masking of laser pulses by fluid. Intralase also uses an infrared (1053 nm) for flap creation. The laser pulses are extremely short, 500–900 femtoseconds) and are focused to a precise depth in the corneal stroma. The laser pulse creates microplasmas in the stroma through photodisruption and thousands of gas bubbles are produced, and these coalesce to form a reaction plane (Figure 1) and subsequently a planar corneal flap which is uniform in thickness. In contrast, the thickness of corneal flaps created by the microkeratome is influenced by the footplate thickness and pressure of the suction ring, corneal curvature, and intraocular pressure. The configuration of a microkeratome flap often takes the form of a meniscus shape, where the centre of the flap is thinner than the periphery. This increases the risk of a buttonhole in the flap, especially in cases with steeper corneas.

Many studies have been performed to compare the efficacy, safety, flap thickness, surgical time, visual recovery, inflammatory response, induced aberrations, wound strength, haze occurrence, etc., between mechanical versus laser keratotomy during LASIK.

In a prospective contralateral eye study by Durrie, it was found that 96% of eyes achieved an unaided visual acuity 1 month after Intralase LASIK, as compared to 88% after mechanical keratome LASIK. At 3 months, this was still 96% versus 86% respectively. It could be due to the fact that Intralase flaps induce lower higher-order aberrations. This may also explain why there was significant improvement in mesopic contrast sensitivity at high spatial frequencies.

Publicity and marketing aside, Intralase is indeed an important consideration from the medical perspective, albeit an expensive one. It involves using a femtosecond laser in the infrared region (1053 nm) for flap creation. The laser pulses are extremely short (500–900 femtoseconds) and are focused to a precise depth in the corneal stroma. The laser pulse creates microplasmas in the stroma through photodisruption and thousands of gas bubbles are produced, and these coalesce to form a reaction plane (Figure 1) and subsequently a planar corneal flap which is uniform in thickness. In contrast, the thickness of corneal flaps created by the microkeratome is influenced by the footplate thickness and pressure of the suction ring, corneal curvature, and intraocular pressure. The configuration of a microkeratome flap often takes the form of a meniscus shape, where the centre of the flap is thinner than the periphery. This increases the risk of a buttonhole in the flap, especially in cases with steeper corneas.

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Clearly, there are advantages and disadvantages with each method. From the surgeon’s perspective, besides considering all the factors mentioned above, the choice between the two will depend on which type of complication the surgeon feels more comfortable handling, which technology most local refractive practices are employing, and ultimately, the budget of the practice.

By A/Prof Heng Wee Jin, NHG Eye Institute @ TTSH.

Correcting Astigmatism in Cataract Surgery

Introduction

Rapid advancements in cataract surgery technology have made it possible to perform a 2-stage surgical procedure to correct high refractive error. In this article, we will discuss the various surgical techniques that are available to correct the astigmatic component of cataract surgery. A/Prof Heng Wee Jin

Intra-operative Astigmatism Correction

By A/Prof Heng Wee Jin, NHG Eye Institute @ TTSH.

Intra-operative Astigmatism correction

Intra-operative Astigmatism correction is another component of cataract surgery, which is a difficult task, especially when the surgeon has to correct the astigmatism of the cornea. The surgeon must be careful when performing the operation, as any error in the intra-operative astigmatism correction can lead to a poor visual outcome.

By A/Prof Heng Wee Jin, NHG Eye Institute @ TTSH.

"Bit-size" information on LASIK for Optometrists

By Dr Jimmy Lim and A/Prof Heng Wee Jin, NHG Eye Institute @ TTSH.

LASIK for Optometrists

LASIK is a laser-assisted in situ keratomileusis (LASEK) procedure that is performed on an awake patient under local anesthesia. The procedure involves the use of an excimer laser to reshape the corneal stroma, which results in the improvement of vision without the need for spectacles or contact lenses. LASIK is a popular choice among patients who want to improve their vision and avoid the need for spectacles or contact lenses.

By Dr Jimmy Lim and A/Prof Heng Wee Jin, NHG Eye Institute @ TTSH.

Common side effects of LASIK surgery include:

1. Dry eyes
2. Reduced or over-correction
3. Infection
4. Scar formation
5. Rate of complications such as slow healing

By Dr James Pan, NHG Eye Institute @ TTSH.

By Dr James Pan, NHG Eye Institute @ TTSH.

By Dr James Pan, NHG Eye Institute @ TTSH.

By Dr James Pan, NHG Eye Institute @ TTSH.
**WHAT'S ON**

The TTSH Eye Alignment Clinic and Children’s Eye Centre recently opened its doors. The colourful and safari-themed clinic is located on level one of the TTSH Medical Centre and is a specialised centre for treating eye alignment problems in adults and children, pediatric ophthalmic diseases and optical services.

**Upcoming Events**

<table>
<thead>
<tr>
<th>Date/ Time</th>
<th>Venue</th>
<th>Title</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Aug 2008</td>
<td>Alexandra Hospital</td>
<td>Diabetic Retinopathy</td>
<td>Ms Alice How: 6379 3741, 6379 3540 (fax) <a href="mailto:Alice_how@alexhosp.com.sg">Alice_how@alexhosp.com.sg</a></td>
</tr>
<tr>
<td>16 Aug 2008</td>
<td>TTSH Theatre, 2-4pm</td>
<td>Cataract (Chinese)</td>
<td>Ms Lim Sing Yong/Lalitha: 6357 2678, 6357 7648 <a href="mailto:sing_jong_LIM@ttsh.com.sg">sing_jong_LIM@ttsh.com.sg</a></td>
</tr>
<tr>
<td>20-26 Sep 2008</td>
<td>AH/TTSH</td>
<td>AMD Awareness Week</td>
<td>Ms Alice How: 6379 3741, 6379 3540 (fax) <a href="mailto:Alice_how@alexhosp.com.sg">Alice_how@alexhosp.com.sg</a></td>
</tr>
<tr>
<td>19 Jul 2008</td>
<td>TTSH</td>
<td>Case Studies on Approaches to Common Ophthalmic Problems</td>
<td>Ms Lim Sing Yong/Lalitha: 6357 2678, 6357 7648 <a href="mailto:sing_jong_LIM@ttsh.com.sg">sing_jong_LIM@ttsh.com.sg</a></td>
</tr>
<tr>
<td>20 Sep 2008</td>
<td>2-4pm</td>
<td>GP workshop on Eye Examination Techniques in Family Practice</td>
<td>Ms Lim Sing Yong/Lalitha: 6357 2678, 6357 7648 <a href="mailto:sing_jong_LIM@ttsh.com.sg">sing_jong_LIM@ttsh.com.sg</a></td>
</tr>
<tr>
<td>19 July 2008</td>
<td>TTSH Eye Centre, Level 1 Attium</td>
<td>The Seven Habits of Highly Effective Researchers</td>
<td>Mr Wasumathe Sukumar: 6357 7678, 6357 3501, 6357 7649 (fax) <a href="mailto:Wasumathe_Sundaram@alexhosp.com.sg">Wasumathe_Sundaram@alexhosp.com.sg</a></td>
</tr>
<tr>
<td>30 July 2008</td>
<td>8.30-10.30am</td>
<td>Continuing Optometrists Education</td>
<td>Ms Alice How: 6379 3741, 6379 3540 (fax) <a href="mailto:Alice_how@alexhosp.com.sg">Alice_how@alexhosp.com.sg</a></td>
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</table>

**NHG Eye Institute Research Publications**

Ang MH, Chew PT, Wong HT, Au Eong KG, etal

Tan CS, Wong HK, Yang PP, Lee JJ.

Woo JH, Au Eong KG.

Wagle AM, Sangtam T, Eong KG.

Sanjai S, Wagle AM, Au Eong KG.

**Test Your Quiz**

**EYEQ**

A 50-year-old lady of small stature (body weight 52.4kg), with seronegative rheumatoid arthritis was treated with hydroxychloroquine for 11 years. She noted intermittent blurring of vision. Fundus photos and automated visual fields showed the following.

1) What do the pictures show?
2) What is the most likely diagnosis?

**Answers**

**Quiz Master:** Dr Stephen Teoh,