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Technologies and Methods for Visualizing the Retina

You are listening to ReachMD XM 160, the channel for medical professionals. Welcome to our show, The Revealing Retina, presented by the American Retina Foundation, the charitable arm of the ASRS, the American Society of Retina Specialists. I am your host, Dr. Roy Levit, chairman of the American Retina Foundation and joining me today, is Dr. Richard Rosen. Dr. Rosen is a vitreoretinal specialist. He was a graduate of the University of Miami School of Medicine. He did his ophthalmology residency and vitreoretinal fellowship at New York Eye and Ear Infirmary. He is surgeon director for the department of ophthalmology as well as director of ophthalmic research in the Infirmary's Advanced Imaging Center.

DR. ROY:

Welcome to The Revealing Retina, Dr. Rosen.

DR. ROSEN:

Thank you Roy. It is a pleasure to be here.

DR. ROY:

We are going to talk about ways of looking of the retina. We both know that there are many ways to examine the retina from the direct ophthalmoscope. Seeing only the optic nerve, macula, and the central vessels to indirect ophthalmoscopy, which enabled us to see the entire retina out to the periphery and also fluorescein angiography, which enabled us to evaluate the retinal vasculature with fluorescent dye. Now new technology gives us almost the pathology-type of slide view of the layers of the retina in a noninvasive way. This is called OCT. I would like for you to talk a little bit about that now.

DR. ROSEN:

Sure. OCT has really revolutionized our ability to examine the retina, much like a pathologist would do, but in a living patient an in a fairly comfortable and very quick kind of examination. Basically the patient sits in front of the instrument and a fairly low intensity infrared light is used to scan across the retina very rapidly and it gives us cross sectional pictures, which look very much like microscope slides of the retina. This technology was introduced originally in about 1990 and has continually progressed in terms of the quality of the image and the kind of information that we can see. Currently, the commercial units that are available claim to be at the order of about 5 microns. Now, 5 microns is a little bit smaller than a red blood cell and while we can actually see detailed cellular details, partly because of the movement from just breathing and from the heart rate, we are able to appreciate very fine layers of the retina, which would otherwise be invisible even to a very close examination with a contact lens and a slit lamp. So very, very subtle pathology that was otherwise unavailable to us, is now a part of our everyday armamentaria in terms of treating patients with a whole variety of visual complaints. It is noninvasive in the sense that we do not have to inject any kind of dye. It is very similar to ultrasound in that it is basically a reflection;

instead of reflecting sound, it is a reflecting light waves. The kind of thing that we can see is a retraction on the retina, which produces swelling. We can see the earliest signs of diabetic eye disease, the earliest signs of macular degeneration, and several other more exotic forms of retinal pathology as well being able to examine vascular occlusive disease. This basically turned the whole examination sort of around very much the way, I would say the modern scanners like CAT scan and MRI have done for the general medical practitioner.

It has opened up a whole range of information that very quickly allows us to make more sophisticated decisions in terms of patient management. We feel much easier now to scan the patient prior to seeing them because we have the information at our fingertips. Thus we know the patient has some new complaints.

DR. ROY:

This particular instrument is one in which the patient sits in front and looks into a small opening and the scan is then done through an undilated pupil.

DR. ROSEN:

It can be done through an undilated pupil, yes. Oftentimes, if the patient has any sort of lens changes or anything in their visual axis such as if they got some blood or some other opacity in the vitreous, it is a little better quality image if the patient is dilated, but most of the instruments will get through a pupil about size may be 3 to 4 mm, easily.

DR. ROY: The scan then, you said, was an infrared as opposed to a laser.

DR. ROSEN: Correct. If a diode similar to a light emitting diode, an LED, that we are used to seeing in various instruments displays. Certainly, the amount of exposure of light is very, very low. It is on the order of probably 5-to-600 microwatts, which is well below anything. And the wavelength, because it is in the infrared, is very safe.

DR. ROY:

What does a physician see on the monitor when the scan is done.

DR. ROSEN:

The newer instruments actually use a combination of the view that you would get from the ophthalmoscope, sort of an unforced or a direct view. You can actually see the fundus very much like contact lens or an indirect ophthalmoscope view and simultaneous to this, they will see a cross sectional image, which will show really from the vitreous down into the choroid and all of the layers of the retina are readily available.

DR. ROY: Let us take macular degeneration. I am talking about wet macular degeneration, where there is an actual leakage from the blood vessels. What does it show you in an untreated eye as opposed to an eye, which has been treated either with laser or with an injection with an anti-VGEF substance?

DR. ROSEN:

Well in an untreated eye, it will show you the presence of fluid, which causes the elevation of the retina. I can show you the presence of blood under the retina or in the retina or actually in the choroid. It shows you by looking at the profile of the retinal image; you can actually see where the particular lesion is, so much so that many practitioners feel comfortable using this instrument in lieu of doing a

fluorescein angiogram to diagnose wet macular degeneration. In a treated eye, basically, you will see the re-absorption of the fluid.

A sort of a return of the more normal profile of the macula, which sort of appears somewhat like a cupid's bow kind of appearance, with a little depression at the fovea. That profile is lost when there is any sort of fluid underneath, which would correspond to the area that the patient cannot see.

DR. ROY:

So we are actually looking at what would be a cross section through the retina

DR. ROSEN:

Correct.

DR. ROY:

And it then shows where the fluid is located. Whether it is underneath the layers of the retina or the choroid.

DR. ROSEN:

Yes, it shows where the fluid is located. You can actually take measurements-very precise measurements in terms of microns of elevation and thickness of the retina. You can use that information to track how successful you are in terms of your treatment.

DR. ROY:

In following a patient who has been treated for wet macular degeneration, if the fluid is absorbed and then comes back on another visit, this is an indication for further treatment. And the OCT is a way to follow this?

DR. ROSEN:

Yes, it is a very precise way. It is very easy for the patient because they do not have to have an invasive examination and it lets the doctor to know right away what the situation is in terms of the degree of leakage and whether the patient needs re-treatment.

DR. ROY:

In a diabetic patient that has swelling in the macular area, is this OCT useful there?

DR. ROSEN:

It is very useful and one of the problems with diabetic patients is because they are unlike in macular degeneration where it tends to start in one spot. Oftentimes in diabetic patients, there will be multiple areas that are involved corresponding to different lesions on different blood vessels. One of the difficulties that people had in the past when they first developed photocoagulation for treatment of macular disease, was trying to assess whether the retina was swollen or not. We found from the studies that it was not so much whether there were these edema residues, these hard exudates as being an indication for treatment, but actually increased thickening of the retina as being a sign that the patient needed treatment. One of the difficulties would be that assessing that thickness at a level that was early and not consistent to allow early intervention, was something that was difficult to master. Oftentimes, even in a trained expert, there were certain individual clues that would make it confusing. So, if you would see these yellow and hard edema residues under the retina, oftentimes people would interpret that it as being retinal thickening. In fact, we see now when we do OCTs in those patients, that many times there is no fluid at all.

So those patients do not really need photocoagulation and are better served by not treating them. So it is a sort of cutback on some of

the treatment and probably preserved visual function in that way.

DR. ROY:

You have talked about OCT that is in general use now. What is online for improvements in this type of examination?

DR. ROSEN:

Well the instruments, aside from improving in the quality of the image by the actual size of the units of resolution, are becoming faster and one of the great difficulties in terms of resolution is eliminating movement artifact because when you are trying to discern things that are on a micron level, just the heartbeat or the breathing of the patient is enough to make the image a little bit blurry. So, the next generation currently, what we are working on, is called spectral OCT, which uses a spectrometer to very rapidly interpret the reflections of the light. The next step is going to be fat broad band with sources of light, which will increase the speed probably another order of magnitude. So, what that will give us will be better quality in 3 dimensional reconstructions of images, which will let us study these cross sections across a much larger area of the retina. Currently, what we rely on is individual cross section, which probably represents about 10-to-20 microns in thickness.

When we see one of these cross sections, we are looking at a very small slice of the retina. What we would like to be able to do is actually reconstruct the whole block of retina that we can cut through and look at more subtle forms of pathology. That is currently in laboratories around the world. The hang up at this point, is of course, that as you develop new technology, they are very expensive and they have, you know, various glitches, but very rapidly these things are being overcome. So, I would anticipate probably within another 5 years, these sources will become readily available and they will be become an expensive enough that they will be common place in our clinics.

DR. ROY:

Dr. Richard Rosen, I would like to thank you for speaking with us about OCT and retinal imaging.

I am your host Dr. Roy Levit, and I would like to thank you for listening to The Revealing Retina, presented by the American Retina Foundation. For more information, visit us online at americanretina.org. We will welcome your questions and comments about this or any other show. Please send your E-mail to XM@reachmd .com or visit us at www.reachmd.com.