Imaging Interpretation for the Comprehensive Eye Care Professional

Instructor:

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Section:

Principles of Diagnosis

COPE Course ID:

40258 PD

Expiration Date:

January 27, 2017

Qualified Credits:

1.00 credits - $39.00

COURSE DESCRIPTION:

The following interactive course will focus on OCT interpretation using clinical cases. It will provide an overview of interpretation and diagnostics in retina and glaucoma management using OCT and perimetry. Structure and function will be discussed in detail.

LEARNING OBJECTIVES:

- Understand the challenges of diagnosing glaucoma and a variety of retinal conditions.
- Be able to understand the basic principles of neuroretinal imaging technology specifically spectral domain OCT
- Be able to recognize the signs and symptoms of a patient undergoing hydroxychloroquine toxicity and the importance of OCT technology and perimetry in management
- Be able to recognize the signs and symptoms of a patient with glaucoma and the importance of OCT technology and perimetry in diagnosis and management
Welcome. My name is Blair Lonsberry, and I am a professor at Pacific University College of Optometry. Today’s presentation is focusing on imaging interpretation for the comprehensive eye care professional. Really looking at how imaging equipment can enhance the diagnosis and management of our patients in our clinics. Today’s presentation is interactive, so I want you to grab a paper and a pen because what I want you to do is to be able to write down your answers to cases that I’m going to present to you. At that point, you’ll be able to compare your answers to other doctors who have answered the same questions.

I am a paid consultant for the following companies:

- Alcon Pharmaceuticals
- Bausch and Lomb
- Carl Zeiss
- Meditec
- NiCox

In addition, I would like you to do what’s called a commitment to change. I want you to write down three things that you learned from this presentation that you can incorporate into your practice to take care of patients better. Ultimately that is why we attend continuing education – to take care of patients better.

This is an interactive presentation, so you there will be questions for you to answer on each case. I think that’s the best way for us to learn, to really look at cases and at how the imaging equipment can help us in these cases. And you will be able to compare your answers to other practitioners who have answered the same questions.

To get started, what we are looking for in our imaging equipment is to give us some objective assessment about what is going on with our patient, be it the retina, the optic nerve, or the nerve fiber layer.

Regarding glaucoma, we have diagnosed glaucoma based on changes to the visual field. Understanding the visual field is very subjective, and potentially require 50% loss of the nerve fiber layer before we are able to see a visual field defect. So what we are looking for are changes to the optic nerve or the nerve fiber layer that would happen prior to waiting for a visual field defect. If we can find a piece of equipment that will give us an objective assessment of either the nerve or the nerve fiber layer, we could potentially diagnose or monitor our patients for glaucoma prior to waiting for a visual field defect.

Figure 1: Visual field changes occur late in the disease. The optic disc often changes before visual fields. The retinal nerve fiber layer usually changes before both the visual fields and optic disc.
With respect to the optic nerve, we know that when we look at optic nerves the first time a patient walks into the office, we really don't know if that nerve is normal or abnormal. Unless it’s a .9/.9 C/D, we really don’t know if that’s abnormal for that patient or if there is potentially a change in time. In particular I get concerned about those small nerves that have potentially a .2 C/D, we may underestimate the potential that there is glaucoma there. I think we way overestimate sending patients off who have a .6 C/D in a larger optic nerve. Because it is such a subjective assessment, and we may not have prior records on a patient, we have a very hard time identifying whether or not there are changes going on with those optic nerves. It’s at best semi-quantitative. We know that even if when we assess the C/D ratio, if we grade it as a .5 or a .6, we don’t even grade those intervening changes, even though glaucoma would go through a .51, .52, .53, etc., but we cannot even assess that. So what we are looking for in our equipment is to be able to give us an objective assessment, that is repeatable, and potentially compared to a normative database to say, “Is this optic nerve and nerve fiber layer in the normal range, or is it potentially abnormal?”

We are primarily going to focus on the Cirrus OCT today. What I’d like to do is go through some of the basics of the Cirrus OCT and the scans that it can do.

Figure 2 is a classic picture for what we look for in a cross-section through the retina with an OCT. The top picture shows all the layers that are there, in pretty good detail. Down below you’ve basically got a grey scale, or a black and white image of the color photo that is above. The color image is really pretty to look at, but ultimately that’s an arbitrary color that’s given for the different reflectance that’s seen. What you’re seeing in the bottom picture is really the true image that’s going on. So ultimately while we like to look at the colored pictures, what you really want to look at is that grey scale photo that is below. You want to take a look at that to see what is really going on with the different retinal layers.
When we do our scans, there is a cube that we put over whatever structure we want to look at. With respect to the optic nerve, you want to put this cube over the optic nerve, and you want to center it pretty well over the optic nerve (Fig 3), but ultimately what the equipment does is auto-center it. It will find the center of that cup, and put the scan over the top of that, and that is where it will analyze. For the nerve fiber layer, it’s going to take a 1.73mm radius around the optic nerve, and measure the nerve fiber layer from that area.

The nice part about the Cirrus OCT is that it registers those blood vessels that are on the retina. What that registering does is that any scans that are done in the future will overlap those blood vessels from the previous scans and make sure that the analysis of the nerve fiber layer and optic nerve happens from the same point. When we had the Stratus before, all of your scans were very dependent on where you put that scan. So if you happened to decenter it one time, now the patient has glaucoma. The next time you entered it, and then they don’t. In this case, the AutoCenter function really takes the guess-work out of play. Because of the registration of those blood vessels, the same scan is taken over, and over, and over again. Ultimately you don’t have to worry about where the analysis is happening because the machine will register those blood vessels and make sure that the same analysis happens.

When we are looking at the optic nerve, what we are looking for is that the termination of Bruch’s membrane really defines the disc’s edge for us. Then the scan goes through, looking at the neural retinal rim, also giving us parameters such as the vertical C/D ratio, the C/D ratio of the total cup volume, it gives us all of these different parameters, but it uses Bruch’s membrane as the termination for the edge of the optic nerve. (Fig 4)
Figure 5: Cirrus OCT printout

Figure 5 is a printout that shows us not only a printout of the nerve fiber layer, but also the optic nerve head analysis. I’m going to go through each of these parts individually in a little more detail, but the first thing we tend to look at is the table full of data at the top center of the printout. I tend to be pretty visual, so I also like to look at the deviation maps (2nd row down on the outer edges). Hotter colors tend to show areas that are thinner in respect to the nerve fiber layer. I love the TSNIT curve (3rd row center) showing us the overlap of the left and the right eye. We know glaucoma is an asymmetrical disease, so we want to look for changes and differences in these TSNIT curves. We also have our pie graphs (bottom center) showing us the different quadrants that might be affected.

Remember that our signal strength becomes very important. Your normative database is really only based off of age – it is not based off of signal strength, or anything else. So you want to make sure you’ve always got a good signal in your scan to be able to use it. That also becomes particularly important when you are doing GPA analysis. Crap in equals crap out. If you’ve got a scan with a signal strength of 3, you really don’t want to incorporate that into your GPA analysis, because it will throw the analysis off. If you are having a hard time getting a good scan, what you want to do is have a bottle of artificial tears near your equipment, put a drop in each eye, and make sure that your patient’s eyes are really lubricated in order to get a good scan.

If you are finding that your signal strength is still down after putting in the artificial tears, make sure that the patient’s head is perfectly aligned vertically. Any head tilt at all can start to throw off some of your data.
Here are each of the individual parts of the printout shown in Figure 5. The area that you want to go look at first is the table shown in Figure 6. Average RNFL thickness is what we use clinically. It is the best indicator for potentially picking up glaucoma, as well as detecting changes in glaucoma. Looking at this Average RNFL thickness, the different values are going to have highlights. Green is normal, yellow is a little bit suspicious, and red is abnormal. The next thing I always look at is this symmetry index. You could potentially have a patient who is green in both Average RNFL Thickness parameters here, but does that mean that they are good to go? That there is no way that they have glaucoma? We know that is not the case. You could have a patient who may start off on the upper part of the green in their TSNIT curve (Fig 7) but now they are in the bottom part of the green. Glaucoma is a change over time, so you could potentially have someone who is green in their Average RNFL Thickness, but if their Symmetry is off, to me that is highly suspicious.

Again, you want to also take a good look at the overlap on the TSNIT curves between the two eyes, looking for symmetry between them for each of the eyes. Glaucoma is an asymmetrical disease so for me the Symmetry index is very important. It’s probably the 2nd thing I look at after looking at the table to see their Average RFNL Thickness, which is what I tend to use as my first parameter when I look at a brand new scan on a brand new patient. I like to use the nerve fiber thickness to say, “Is there a problem going on with this patient?” But then always look at their symmetry indexes.

Then we have all of our optic nerve head parameters. We have our Rim Area, Disc Area, Average C/D Ratio, your Vertical C/D Ratio, which we know is one of those first signs we look for in glaucoma – that vertical elongation. We also have the Cup Volume. Figure 7 shows us our different graphical representations of that information.

The next thing we are going to talk about is GPA analysis, or Guided-Progression Analysis. We have true GPA analysis with Cirrus OCT. We had something similar in the Stratus, but the difficulty with the Stratus was that it was so dependent on where those scans were that you may not have been analyzing exactly the same tissue. With the new SD-OCT, because those blood vessels are overlapped, you get the exact same analysis happening over, and over, and over again.
To get a true GPA, you need two baselines for your analysis, and you want to do those two baselines on the same day. Those become true baselines. Once you have your two baselines, then you can do GPA analysis the next time the patient comes in. If you were to, say, separate your two baselines by a year, then those aren’t true baselines at that point, and now you’re waiting 2 years before you can do GPA analysis. So on your first day, you want to do two scans in each the right and the left eye. You have to manually go into the GPA analysis and manually select those two scans that are done on the first day as your two first baselines. If you don’t, it just chooses the last scan on that day if you do an automatic selection. Really, you should be manually selecting for your GPA analysis – do not let the equipment choose for you. This lets you go in and choose your best scans, make sure the signal strength is good, and that you get the best information to make your GPA analysis.

Because you have your two baselines as your first scans, anything that changes in that cube of data that is being analyzed will be flagged in a different color. If on your follow-up scan, you have a change from those two baselines, the change will be flagged in yellow. If successive scans have changed from the baselines and that third scan, the OCT will start flagging those pixels in red. This is giving us a true look at what is changing with respect to the nerve fiber layer.

Figure 9 shows the printout that you get for your GPA of the nerve fiber layer. Your two baseline scans appear in the upper left, and the successive scans are shown on the upper right. Looking at the Average RNFL Thickness, which as I said before, is the indicator we tend to use most often. We also get changes in the C/D ratio, as well, in the graph showing the average C/D ratio change. Below that, we get our TSNIT curve, which overlaps all those scans that we are taking. It will again show you changes in yellow or red. On the right of the printout, we get the Superior RNFL Thickness and Inferior RNFL Thickness. And, ultimately, if you don’t want to look at any of those primers, you can look at the little cheat box in the lower right, and the check boxes will tell you whether or not there is a change. If there is a change in
RNFL Thickness, or in any of the other four parameters, it will give you a little check in the box saying is it likely or potential progression. Even if you don’t look at any of the other parameters, you can just look at the little cheat box in the bottom right hand corner.

Figure 9: GPA printout
We now have GPA analysis for the optic nerve, as well. (Fig 10) If you have the 6.0 upgrade, you not only have the GPA analysis for the nerve fiber layer, but you also have GPA analysis for the optic nerve. I really like this new addition to the software. I tend to look at the nerve fiber layer as my first indication in a first-time patient and ask, “Is there a potential concern with glaucoma looking at those nerve fiber layer changes?” But I really like to see the changes in the optic nerve in patients who have successive scans to see whether or not there is any progression related to glaucoma. The addition now of having GPA analysis for the optic nerve, for me, is a really important addition to the software.

Figure 10: GPA for the optic nerve. A new addition with the 6.0 upgrade.
The nice part about having an OCT is we not only get the nerve and the nerve fiber layer, but we also get the retina, as well. Figure 11 is a Macular Cube Scan, so the same cube that we were using to analyze the optic nerve and the nerve fiber layer is now put over the macula area. Again, it’s got a foveal finder, (Fig 12) so even if the scan is not perfectly aligned, it will find the center of that fovea so that we can have successive scans that happen at the same point so your analysis of the thickness of the macula happens from the same point.

Figure 11: Macular Cube Scan

Figure 12: Foveal Finder ™
Left: Macula Thickness Analysis is aligned with the fovea.
Right: Resulting analysis may differ from analysis aligned on scan center
There is a normative database that is associated with the macular thickness. (Fig 13) Remember that the green range is the normative range. The 5% that fall below that are in the yellow band, and the 1% in the red are considered outside of the normal limit. Note that outside of the normal limit could be thicker or thinner, and really, we need to pay attention to that. You need to look at the numbers on the scan (lower left pie chart in Fig 13), and decide if your patient is really thicker or thinner as compared to the normative database.

We can also do a Macular Change Analysis (Fig 14), again, because it finds the center of that fovea so we get the same analysis happening over and over again. This means you can look for changes over time – say if your patient has macular edema and you’ve sent the patient for treatment. You can now look at the successive scans to see if there is a difference in the thickness.

Ganglion Cell Analysis is the new parameter that we tend to look for. All the pieces of imaging equipment out there tend to do this a little bit differently. With respect to the Ganglion Cell Complex, it includes the Ganglion Cell Layer (GCL), the Inner Plexiform Layer (IPL), in addition to the Retinal Nerve Fiber Layer (RNFL). The Cirrus OCT analyzes this a little bit differently – it scans all three of those layers,
but it only looks at the ganglion cell layer and the inner plexiform layer in its analysis. It scans all three layers, but it pulls the RNFL out. The other pieces of equipment do it a little bit differently, so depending on whether or not you have a Spectralis, or an RTVue, you need to look and see how they are analyzing their Ganglion Cell Complex. Back to the Cirrus, it pulls out the RNFL, because you’ve already gotten that measurement in your previous analysis, so it just looks at the GCL and IPL.

![Figure 15: Ganglion Cell Analysis printout including Thickness Map, Deviation Map, Horizontal and Vertical B-Scan, as well as sectorial thickness values colored in red (abnormal thickness) and green (normal thickness).](image)

It’s thought that with Ganglion Cell Analysis (Fig 15), what we are doing is potentially seeing changes that might happen earlier than waiting for RNFL or optic nerve head changes. The thought is that the very first visual field defects that we tend to see in glaucoma are paracentral scotomas, and with that, you want to be looking around the foveal area to see if there’s any changes in that ganglion cell complex. Thoughts are that we may be picking up potentially earlier defects before we were seeing changes in the RNFL or with the optic nerve.

Your printout shows you a deviation map (top row, central images), it also gives you the pie graphs on the bottom that shows you areas where thickness is outside the normal range.

**The course continues on Part 2**