# Achieving optimal outcomes with laser refractive surgery

At the meeting of the ASCRS in San Diego this year four ophthalmologists met at a *EuroTimes* roundtable to discuss the current state of knowledge in refractive surgery and the degree to which current laser technologies are able to provide patients with optimal vision.

Emanuel Rosen chaired the session.

**Rosen:** The purpose of this round table is to try and provide some commentary on customised ablations and corneal refractive surgery. To start, I thought we should briefly talk about the eye as an optical instrument. When we talk about customised ablations one has to recognise that there are temporal variations in the optics of the eye. It depends on the patient's age, their pupil size and their state of accommodation. Therefore, if you take a measurement how do you know how stable that measurement is, should we take several measurements?

**Mertens:** When you repeat higher-order aberrations measurements you see a lot of variations. The wavefront can change after only a few minutes because of the effects of tear film, pupil dilation and the drops you use - and that's only the short-term variations. You also have longterm variations like diurnal changes in corneal thickness, and changes in the spherical aberration of the lens with age. In addition, you can have floaters in the vitreous and we don't know what influence they can have on the measurements.

**Rosen:** Thomas, what do you think of the limitations in our ability to do measurements in terms of the optics of the eye?

**Kohnen:** Erik already has summarised some of my thoughts. We have studies that show that the short-term repeatability of the instrumentation we currently use is not very good. We want to get more repeatability; we want to make sure that we really measure the higher-order aberrations correctly at any given time. And of course when we treat patients we always have to keep in mind that the optics of their eyes will change over the years.

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**Rosen:** What are the issues involved when we see patients in whom aberrometry shows a very low RMS in every type of Zernike level and yet they are complaining of halos, of shadows and of glare? And how does one relate these issues to the absence of the things that we try to customise?

**Mertens:** This just shows that we don't know enough about what's going on the eye. Our measurements are rough and Zernike polynomials may not be the ultimate tool for describing the optical quality of the eye. There are many things that they don't account for. We also have to find out which kind of aberrations we should treat and which we should leave. It may not be a good thing to treat higher-order aberrations. Instead, it may be a better idea to have an optimised laser profile creating a more prolate cornea. And, of course, when you have opacities of the crystalline lens then it is the lens rather than the cornea that should be treated.

**Rosen:** I am sure you endorse that, Thomas, the stage of the lens is critical and one of the problems in the past 10-15 years is that there has been a wide assumption that you can correct everything in the cornea when there are ever-changing conditions in the lens.

**Kohnen:** The status of the lens should in refractive surgery always be considered. When I surveyed my own practice I found that over the past five years I've been performing LASIK surgery on a decreasing proportion of my patients and I've been performing phakic IOL implantations and refractive lens exchanges on an increasing proportion.

**Rosen:** Before we discuss custom ablation we should talk about the data that we as mere clinicians can have access to when looking at patients. What do we need and what can we get and how can we use it and what are the relative merits of topography versus aberrometry?

**Mertens:** When we look at the cornea you have to decide whether this cornea is fit for laser surgery, that's the main goal of topography. The second goal is to measure aberrations specific to the cornea, particularly when prior surgery has induced a lot of aberrations. You have to look at the topography of the cornea because that is where those aberrations originate and it is the surface of the cornea you will have to treat. Aberrometry is okay for measuring a small amount of higher-order aberrations but when we have a lot of higher-order aberrations you need a very good topography system.

**Rosen:** Thomas, in the case of myopia what are the limits in keratometry as seen on topography that would make you limit your treatment? In other words, how flat would you make the cornea in myopia and how steep would you make the cornea in hyperopia?

**Kohnen:** I'm always in favour of not going to the limit of corneal surgery and therefore limits in the higher range would not go beyond 48-49 dioptres. In terms of flattening as I only treat on the cornea up to -8.0 D I don't go below 33.0 D or 34.0 D, but I think that's still much too low.


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**Mertens:** I think we should make the cornea no flatter than 35 D and no steeper than 50 D. You can almost never achieve 50 D but, as Thomas said, 48-49 D is probably more reasonable.

**Rosen:** I think 50 D is way over the limit. I think what you have to look at is the gradient and the effective optical zone. If you have a small optical zone and a very steep gradient from 50 D in the centre to 35 D in the periphery then no optical system can cope with that. So my preference is certainly not steeper than 48 D and not flatter than 36 D.

*Jose Guell MD joined the discussion at this point*

**Rosen:** For the sake of this discussion, what do we mean by the term customised ablation?

**Kohnen:** Customised ablation is ablation that is tailored to the needs of the optical system, in terms of corneal shape and in terms of higher order aberrations, to this particular eye rather than just basically treating the refractive error.

**Rosen:** Yes, it is individualised and it's moving beyond lower-order aberrations, where we use normalised algorithms based on data from thousands of patients, to utilising data gleaned from aberrometers that are specific to that eye. Is custom ablation suitable for all refractive surgery patients or are there some that will benefit more or some who will not benefit?

**Guell:** I do not use customisation with my Mel 80 today because its standard optimised profile is at least as good as customisation.

**Rosen:** At our centre, customised treatments with our LADARVision system are definitely better in terms of not increasing existing aberrations and there's evidence too that it reduces significant pre-operative aberrations.

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**Guell:** Your customised treatments are better than the standard, the question is, is the standard from your system optimised or not? My point is that an optimised, aspheric treatment will possibly be much better than the standard and as good as the customised treatment and probably better. If you look at a virgin, not very aberrated eye and you see how many microns of tissue will be ablated when your treatment includes these higher-order aberrations, sometimes you are talking about only 12, 6, 8, or 17 microns of difference in peripheral treatment. The point is, one single epithelial cell may have a depth of 5.0 microns so with two epithelial cells you may be losing all that you have changed through treatment of higher-order aberrations.

**Mertens:** I would like to come back to optimised aspheric treatment. We cannot predict what we induce by making the flap, because its thickness and size will vary and secondly you induce spherical aberration with your treatment and also when you have trefoil then you can correct it with customised ablation but you can not treat trefoil with optimisation.

**Guell:** I agree absolutely but what I am saying is that to correct the trefoil or coma in a virgin eye will mean 4.0 microns of difference so I don't know if this is something that will really make a difference once the cicatrisation period is finished.

**Kohnen:** I think we also don't know yet what the main outcome of our treatment should be. If we don't know that, then we don't know whether we should use optimised profiles or if we should determine and decrease the higher-order aberrations. I think we are missing some data and that is, what is our optimum profile?

**Rosen:** That's a fair point, one of the points Erik has just raised is the issue of the flap, the variations that can occur with the mechanical microkeratomes. I was speaking yesterday to someone who uses the IntraLase and he says the consistency of flaps has made a big difference to the outcomes. So my question is, do you feel the flap plays a major role in the outcomes of customised ablations, and if so, do you think we should be moving towards a laser-created flaps or doing surface treatments?

**Guell:** There is enough published work demonstrating that flap thickness has absolutely no relation with changes in wavefront. I think that the hinge and obviously the cut itself is the most important single factor. I think that today with the current generation of microkeratomes we can already predict the flap-induced aberrations with quite a good approximation, providing you use a consistent position of the hinge.

**Kohnen:** I wonder if the next generation of microkeratomes will not be as good at creating the flap as the femtosecond laser. I also agree that from the data it's clear that the flap does induce aberrations, if we can learn to predict them we can compensate for that in our ablation algorithms. In any case, I think that a little bit too much hype has been made of the LASIK flap, particularly by people who advocate surface ablations. As regards the surface ablation issue, I think there will always be people who think that preservation of the Bowman's layer is very important and I am one of them.

**Mertens:** Can I make a comment on the IntraLase? When you do an IntraLase flap you lose a little bit of the wow effect because it takes longer for the patients to recover vision. I also do not believe that the IntraLase is giving us better flaps than is

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possible with a microkeratome. But one thing we have to bear in mind is that our patients may drive us towards making laser flaps because they might think it's safer. But this may be a misconception on their part, because I've seen IntraLase being used at the VideoRefrattiva meeting in Milan with Buratto and they had to abort the first cut after a few pulses and start again, so I don't think it's safer.

**Guell:** Yes, when he started the cut he lost suction, that's why the laser was stopped. Then they used another suction ring and they started to cut again. This is something you can do with the laser which you cannot do with a microkeratome. But in the area where the first cut was started you lose some tissue, so in theory you may be inducing some aberrations, basically some local irregular astigmatism. The advantage in using the microkeratome is that if you postpone the surgery at that time and proceed with a new surgery two months later nothing has been complicated, you have a completely restored cornea.

**Kohnen:** An interesting question which has not yet been actually answered is: does IntraLase induce more aberrations than a microkeratome? Because in a cut we are basically separating the lamellae, whereas with the laser we disrupt the tissue.

**Rosen:** I'm very enthusiastic about the reports from the very experienced IntraLase users and the quality of the vision and the absence of re-treatments with customised treatments or optimised treatments.

Now to return to aberrometry, there are several types of wavefront-sensing devices available. Hartmann-Shack seems to be the major system that's used, Tscherning is another type and then there are ray tracing systems of the Tracey typed. Which type of system is best?

**Kohnen:** It's interesting that Schwind has dropped Tscherning they are using Hartmann-Shack now.

**Rosen:** And Jose you have an aberrometer

**Guell:** Yes but it is not exactly an aberrometer, it's a double-pass instrument. It's another way of evaluating an optical system. From my point of view it's much more interesting because in those cases it is where I will really want know what aberrations the cornea has, for example, aberrated corneas, irregular astigmatism, post-surgical corneas, that we have the highest rate of inexact measurement with Hartmann-Shack aberrometers. So currently available aberrometers provide good information in virgin corneas but don't work as well in slightly irregular corneas and are not good in highly irregular corneas. Double-Pass will not give you information that you will be able to use for the laser ablation but it will give you real information about the optical quality of the eye.

**Rosen:** We were talking before about patients who according to our analysis with aberrometry and topography and refraction see a perfect result but they still complain. So far, because we don't have an OQAS double-pass system we are unable to measure or quantify their problem

**Guell:** Exactly. With an aberrometer you are missing scatter and the scatter is one of the most important effects in the post surgical eyes. The first study that we did comparing Hartmann-Shack with OQAS was with people with pre cataract. We found that the aberrometers indicated they had extremely good PSF because they didn't have many aberrations. But the OQAS image was terrible and the patient had a lot of complaints. All this information is missing on the aberrometer so from a diagnostic tool point of view I think that double pass systems, OQAS particularly, are much better.

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**Rosen:** So to summarise our discussion, we can conclude that some laser systems have optimised algorithms while other systems don't optimise the algorithms but instead steer you towards a customised treatment to really achieve the same effect. We have also agreed that although the flap will induce some aberrations, that is something that can be taken into account, and that mechanical microkeratomes are as good as laser induced flap makers as far as the experience in this group is concerned. One additional point I would make is that, in the truly scientific sense, prospective studies are almost impossible in refractive surgery because of the rapid advance of technology and the type of patients we treat. Most of our patients just want a result and want to go away and don't want to be studied, which is why we have all these different systems each of which is obviously working pretty well.