A supplement to
Ophthalmology Times
EUROPE
April 2010

Fluidics in modern vitrectomy

Highlights from an expert roundtable meeting

7 November 2009, Movenpick Hotel, Zurich-Airport, Switzerland

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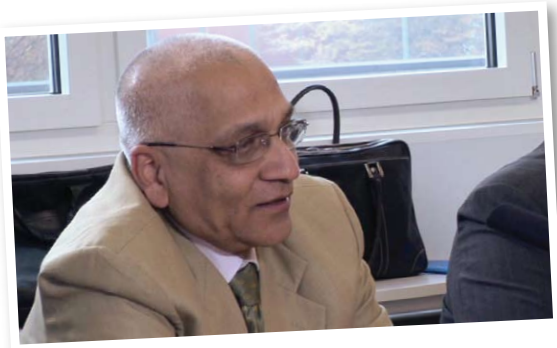

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Introduction

Over the last few years the main topics of discussion in ophthalmic surgery have tended to concentrate on things like power delivery, ultrasound modulation, cutting rates or even duty cycle rather than on the understanding of fluidics. However, greater understanding of fluidics is something that has only recently been recognised as being important, together with the decrease in sclerotomy size and the development of new instrumentation in terms of size, cutting speed, illumination and pilot tubes.

Oertli Instruments, a Swiss designer and manufacturer of equipment and instruments has been addressing the fluidics issue for some time and the research work of their head physicist, Dr Gregor Jundt has concentrated on looking at two pump concepts, flow controlled and vacuum controlled, or peristaltic and venturi. Knowledge of the concepts is critical to understanding the mechanics of these pumps.

Flow rate control (in an unoccluded state) keeps fluid turnover in the eye exactly at the rate controlled by the pedal while the vacuum adjusts itself to the lowest level required.

Vacuum control (in an unoccluded state) keeps the suction vacuum of the pump exactly at the level controlled by the pedal while the resulting fluid turnover depends on vacuum, size of aspiration path and condition of material being aspirated.

In the occluded state, there is no difference between the two systems.

Oertli's research has indicated that surgeons felt that given the development of the changes, which have been highlighted individually, there was a need to look at these in the round and discuss the ideal vitrectomy and vitreoretinal system and ask if there could be a system suitable for all surgical situations.

Subsequently, a meeting was convened for experts to share their experiences and views in a roundtable discussion in Zurich, Switzerland to review where we are today, the surgical situations that arise and what challenges those present. It also aimed to examine the strategies and methods of treatment open to doctors, what instrumentation is available and what their ideal properties are and also what pump systems and settings were most appropriate.

For their preparation, venturi users amongst the assembled expert panel were asked to work for a period of time with the peristaltic pump while peristaltic users did the opposite. The Oertli OS3 system, which offers switching between pumps on the fly, was used for this purpose.

Vitrectomy then and now

Professor Dr Arnd Gandorfer set the scene for the discussion

We are all familiar with the slide showing the 17G cutter used by Robert Machemer at the beginning of the 1970s at Bascom Palmer in Miami. He put it into the eye through a sclerotomy that was about 2.8 mm, at least. It was quite a machine. You can't imagine this happening today, inserting something like that into the eye and performing surgery!

"Later Machamer, O'Malley and Heinz separated the infusion line from the vitrector tip, creating the three-port pars plana vitrectomy that we are talking about today. Now we are all used to the 20G system. That was our standard system in the past; three sclerotomies and surgery is performed via two sclerotomies. We are all used to the wide-angle viewing systems, replacing the contact lenses. Now we are used to the trans-conjunctival approach for minimally invasive surgery which has brought a real sense of achievement to us in terms of minimising trauma and changing techniques.

"Is there really a need to do a roundtable discussion on vitreoretinal surgery? We can easily repair giant retinal tears or can treat PVR, at least in many cases, even those where the retina is going to create a funnel shaped retinal detachment. We can also deal with diabetic eyes and separate the membranes. We can even close large macular holes today.

"So, why is there a need to do a roundtable on vitreoretinal surgery? Well, I believe there is definitely a need to talk about these things. As I have said we were all used to the 20G system with the Kloti vitreous stripper. We probably all learnt our surgery using it, but the 20G system has been replaced and other things have changed. Looking at our annual report

from 2004 – after childbirth procedures, pars plana vitrectomy is number three in procedures performed at the university hospital [Munich], ahead of all other surgeries.

"It really matters what we are doing here. Ophthalmologists are always regarded as being a small faculty within medicine as a whole, but we are number three of all surgeries perfomed in our hospital so the numbers are changing.

"Also techniques have changed, combined procedures, for example. We have all come to accept the transconjunctival sutureless approach using trocars and that has changed the settings and the techniques of surgery tremendously over the last five years; 23G is more or less the standard now.

"Many other things have changed, not so much indications, but complications, results of surgery, time of surgery. When I saw the first vitrectomy personally at the beginning of the 1990s, it lasted roughly three quarters of an hour, in some centres longer. Now a normal vitrectomy, 23G, is done within a quarter of an hour.

"There are also new vitrectomy systems, such as 23G, 25G, pars plana microincision systems (PMS), for example.

"Coming back to today's core topic, the two pump systems - peristaltic and venturi, every surgeon has opinions about using these pumps, but there have been few studies done on the physics and the fluidics of the vitreous. There is less knowledge in this area and there is hardly anything published on it.

"So, with instruments changing, cut rates increasing, new illumination and wide-angle viewing systems and valved trocars, I think it is really time to reconsider the ideal vitrectomy and vitreoretinal system in the whole setting of vitrectomy and that's what we want to shed some light on today - we would all be happy to have one system suitable for all situations."

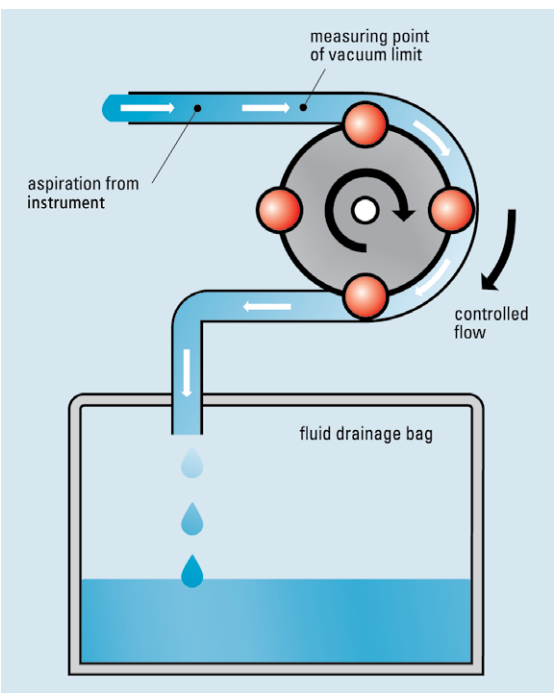


Figure 1: Peristaltic pumps work with flow. By means of roller systems, the peristaltic pump compresses, as the name suggests, the tubing system, so as to create flow and vacuum. The compression of the tubes by the rotating movement 'milks' the liquid column out of the tubing system. While this is happening the flow can be directly controlled. The preset vacuum is achieved as soon as the outflow is occluded, i.e. as a rule, at the tip of the cutter. As soon as occlusion occurs, the vacuum starts building up, the rollers begin to move more slowly and the outflow decreases. How quickly the rollers respond can partly be influenced by how this parameter is preset.

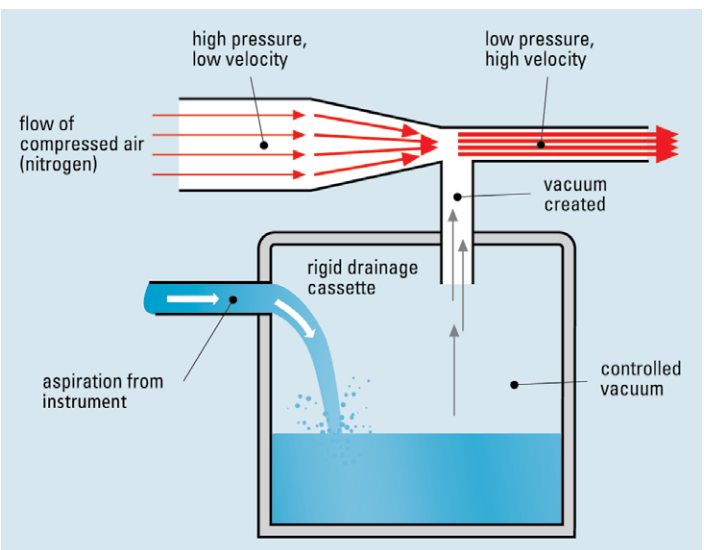


Figure 2: Venturi pumps work with vacuum. The Venturi effect means that a vacuum is created by flow. In surgical devices the flow is generated by compressed air or nitrogen; the air nozzle has a connection to a closed drainage bag (see illustration).

Comparision of the pumps

Peristaltic	Venturi
Based on flow (Vacuum is adjusted automatically.)	Based on vacuum (Flow can decrease when cutting begins.)
Vacuum is generated after occlusion of the instrument tip	Vacuum is directly generated by pump
Flow remains constant until occlusion occurs	Flow varies depending on the strength of the vacuum
Flow and vacuum can be controlled independently of one another	Vacuum and flow correlate with each other
Direct flow control	Flow control via vacuum, cutting speed and duty cycle setting

Six surgical situations

1 Core Vitrectomy

Dr Gandorfer: With regards to core vitrectomy, if we are talking about different pump systems, fluidics, what should we address regarding core vitrectomy? What is important for you? Which pump and machine settings are you using?

Dr Ducournau: Each time the vitreous is healthy and the disease doesn't have anything to fit with the vitreous, that is to say an epiretinal membrane, macular hole, venous thrombosis, all kinds of oedemas, exceptionally floaters – then I perform a core vitrectomy in order to respect all the anterior vitreous and to decrease the number of post-op cataracts and post-op retinal detachments.

Dr Gandorfer: Which pump and machine settings are you using? Are you using a venturi pump or are you using a peristaltic pump, just as regards core vitrectomy?

Dr Ducournau: For all my surgeries I use a peristaltic pump.

Dr Gandorfer: I have to say, so do I. And the settings on your machine?

Dr Ducournau: I always put the maximum aspiration flow at 2 mL per minute lower than my infusion flow, so that I will never have less inflow than outflow. The first thing I do with the vitrectomy machine is to determine the infusion flow at 70 cm, that's where I put my infusion bottle. So for example, with my machine, which is a European machine, I have 24 mL infusion flow per minute and then I put the maximum aspiration flow at 22 mL per minute. I begin my core vitrectomy, to gain time, with a high flow of approx., 20 mL per minute and in order to reduce traction in the periphery I cut at 800 cuts a minute. I think that there is a relationship here. If we consider the risk of traction in the periphery and you use a high aspiration flow - you must use a high cutting rate. It is only when you use a lower aspiration flow that you can use a slower cutting rate.

Dr Gandorfer: Do you do this calibration, 70 cm, on every patient?

Dr Ducournau: For each new machine, it depends on the infusion path.

Dr Gandorfer: Does this apply to 23G?

Dr Ducournau: For 23G you have to adjust. I stopped using 23G and 25G and came back to 20G for reasons of time. For 23G the maximum aspiration flow was about 15 or 16 mL per minute, because my infusion flow was around 17. The goal is always to put the maximum aspiration flow at a lower setting.

Dr Luff: My preference depends on where I am, because I work in different centres with different machines. I work in more than one centre where we have to use a venturi pump, and I use that on both 20G and 23G. My general feeling is that core vitrectomy is a part of the operation that I want to complete quickly; we can do this safely and spend our time concentrating on more important aspects of surgery.

As far as the 20G surgery goes with a venturi - just have the vacuum set on 250 to 300 mmHg and away you go. With the 23G system, and I'm talking about using the DORC system combined with a Bausch + Lomb Millennium machine, I have the aspiration up to 450 mmHg on a linear control, but most of the time we are actually running 450.

When I am using the Oertli OS3 machine, and I would now favour using the peristaltic pump, I am set on 40 mL per minute flow. I haven't been quite as clever as Didier Ducournau, but can tell you that wherever I have my bottle height, the eye seems to stay nice and stable and that keeps me happy.

Dr Das: Mostly, I have been using venturi with my Alcon Accurus. Only about two months ago I changed to the Oertli OS3 peristaltic. For core vitrectomy, I use exactly the same settings as we have just heard for the venturi pump. For peristaltic we have changed to linear control. I don't find much difference between peristaltic and venturi for the core vitrectomy. To my mind, both appear similar and you can do a fast job either way.

The main work actually begins when you go to the periphery or when you have a retina that is moving. I like to do my core vitrectomy as fast as possible, spending no more than five or seven minutes.

When you go to 23G, of course, you have to change the bottle height, you have to have higher pressure and higher suction. I started with 25G but I changed to 23G because of various economical problems in India. So I stick to 20 and 23G.

For surgeries where I do not have to use a belt buckle, I will stick to 23G. Where I have to open the conjunctiva to do a belt buckle then I will change to 20G.

It was once explained to me that 23G is more a technology than a technique, particularly when we get to tips, which I think we will talk about later.

Dr Chawla: For me, core vitrectomy is just a step in surgery, it is never the complete surgery. We normally have two tables

running at the same time, one which I start on the Oertli machine with my colleague on the Accurus.

For the last six months I have been using mostly peristaltic pumps, and have learnt about some of the advantages from experience. As we have become more aggressive with our vitrectomies, especially with posterior hyaloid removals, I did experience some breaks. So, I thought, why not change over to another pump and settings and try things? For my core vitrectomy I normally use a vacuum of 250 mmHg or so for peristaltic and venturi.

The flow rate tends to be a little higher than Dr Ducornau. Mine is more of a clinical titration situation when I change over to a new system. 70 to 80 cm is the bottle height and I titrate my surgery by observing how the eye is behaving at a set flow rate level. I was using a level between 25 to 30 mL, but now I have made it a little higher, 32 to 36 mL.

I tend to use a slightly higher cut rate, even for core vitrectomy, about 1400 to 1600 as I feel it makes the procedure less traumatic. The time this normally takes is about seven to nine minutes. My system of choice, mostly, is 23G.

Sutures are never an issue. If a suture has to be given I don't consider it much of a handicap, and now even if I am using a belt buckle I tend to use a 23G system through the sclera. This is because of the advantages in fluidics with the valved trocar (Oertli PMS), convenience of use and the cutting port being closer to the tip. These are the major advantages that I've found.

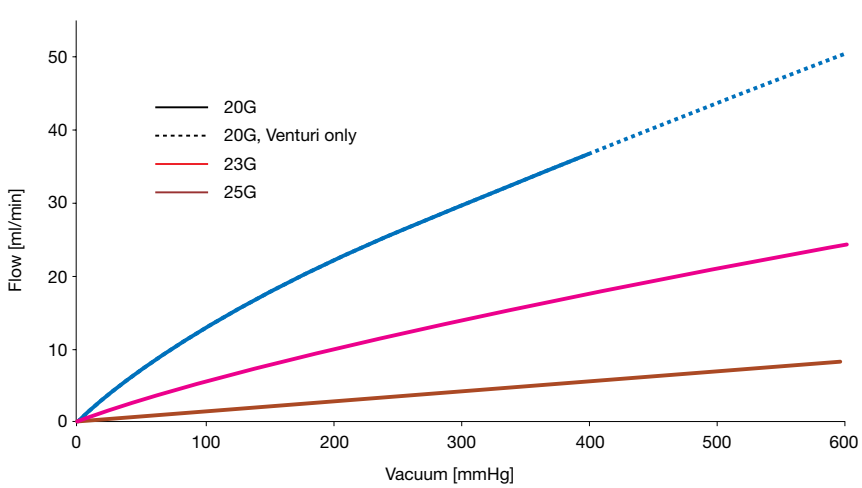
Dr Prünte: It is very difficult to discuss this after four experienced surgeons because I think all the points are on the table already.

I would agree that core vitrectomy is also just a step for me, and I think we are very safe so long as we don't deal with the posterior vitreous membrane. My primary objective is to make it efficient and that is the reason why I use 23G in 100 percent of my cases.

It is the second step of vitrectomy for me, the first extremely important part is to clear the vicinity of the inserts from vitreous and from the vitreous base because I think this creates most of the breaks during the vitreous procedure – if you are always pushing into the vitreous base with your instruments it's because you didn't clear the vicinity.

I routinely use a venturi system, 450 mmHg and an extremely high cutting rate of 3000. I believe this is the most efficient way to do it. In a young vitreous that is very stable, you may have to reduce the cutting rate to get enough vitreous attached to the opening of the cutter. My method of setting the irrigation flow is very empirical, during the core vitrectomy I like to set the bottle as high as possible, but want to make sure that circulation is working during all procedures even without any vacuum activity.

Dr Ducournau: What do you mean as high as possible?



Dr Prünte: I try to titrate the irrigation bottle height without cutting. I use valved inserts (Oertli PMS) because it is a closed system and then I adjust it to a point where I am sure that I have continuous blood circulation, which is individually extremely different. It is not the same height for all patients.

Last week I had a patient, after several other surgeries and I had to put the bottle height to no more than 20 cm otherwise it would cut down the circulation of the retina. This is a very individual point and I try to adjust it to each patient.

Dr Das: How often do you change the bottle height during the same procedure?

Dr Prünte: Sometimes, and this is why I like to have the bottle height on my foot pedal and I don't have to ask for the pressure adjustment. I don't want to have two steps, I just want to work it continuously. For example if I inject dye, I want to have minimum turbulence so I always lower the bottle.

Dr Das: Do you change the bottle height according to the clinical steps you are doing or the kind of patient you have? Let's say I was approaching a diabetic eye, which is a sicker eye compared to that of a young person.

Dr Prünte: There is an individual bottle height and I try to find it out at the beginning of the surgery, when I first see the fundus. Then I may change the bottle height two or three times during the surgery, according to the stage in the procedure.

Dr Gandorfer: It's the same for me. Core vitrectomy is step number two, it is not the actual surgery but a step. I start with a bottle height of 55 cm, which is relatively low and then I try to adjust it as has been said.

Another thing that interferes with the circulation is how stiff the vitreous is. If there is no leakage through the sclerotomies or if you are using a valved system, you can even go down with the bottle height.

I am using the Oertli OS3 system and since then, I have used the peristaltic pump, even for core vitrectomy. I won't switch to venturi again. I always use the highest cutting rate, using a 23G system and I do have a very low flow. My flow is at 12 mL, it is more secure, and my vacuum is always 600 mmHg.

In this first round we have heard different approaches, peristaltic and venturi for core vitrectomy. I would be interested in what Oertli's physicist, Dr Gregor Jundt, says about this topic.

Dr Jundt: We have performed extensive measurements in this area. For the venturi pump we determined the actual flow resulting from preset vacuum values. For the peristaltic pump we measured the actual vacuum resulting from preset flow values. We call the resulting diagram 'vacuum/flow dependence.' We did this for 20G, 23G and 25G instruments with the port fully open (cut rate zero) and in an open system.

The vacuum/flow dependence curves of the venturi and peristaltic systems fully coincide! Only for 20G instruments, at vacuum levels above 400 mmHg, the venturi can exceed 35 mL of flow while the peristaltic system used levels off here. However, surgeons would avoid such settings even in core vitrectomy! But for 23G and 25G there is no difference at all.

Dr Prünte: I would be surprised to see a difference, except for the initial response curve.

Dr Luff: With BSS?

Dr Jundt: Yes, this is just for the steady state values with BSS. In the real vitreous of course you would expect the flow to go down even more, and this makes the two pumps even more equal. If you have more resistance then the flow will be lower.

Dr Ducournau: Dr Chawla, you can see that if you put your flow limit at 35, as you said, you will never reach 35 mmHg with 23G.. The maximum that you can reach is 25 mL. If you put the maximum vacuum at 250 mmHg you can only reach 12 mL per minute.

Dr. Jundt: But Dr Chawla might still experience a difference when it comes to an occluded state, where high flow rates will result in fast vacuum build up; a topic to be addressed later.

Dr Prünte: It's actually interesting. If you really measure it, we work with much lower flows than we expected when we changed to small gauges.

Dr Jundt: This is the reality! And it is the reason why usually surgeons don't like to work with 25G instruments. Whether peristaltic or venturi, you cannot go higher than 8 mL, the internal resistance of 25G instruments is just too big.

Dr Das: And the most you can with 23G is 22 mL per minute, independent of what you are displaying.

Dr Jundt: Yes, it doesn't matter if you set 30 mL or 50 mL maximum flow. It will never be reached. With vitreous it will be even lower than with BSS.

Dr Prünte: What we should not forget is that in the eye we have irrigation pressure from the bottle, which is a baseline pressure. As soon as the cutter port opens, flow will start with the pump still inactive. So, particularly in the beginning of aspiration, we have a much steeper increase. It may come up to the same level later, but at first in the real world the increase is completely different.

Dr Jundt: This is true for a venturi pump only. With the peristaltic pump, there will be no flow unless the rollers start to move. With venturi, it appears like shifting everything on the diagram to the left.

Dr Ducournau: This is why we must speak of the gradient of pressure. The gradient of pressure is the difference between the infusion pressure, which is given by the height of the bottle and the negative pressure (vacuum) induced by the machine.

Dr Prünte: The possibilities to regulate in this system are extremely small. If you say, for example, that from the outset you want to control the system just by linear control of the vacuum and once you reach a certain setting for the vacuum and go on, there is nothing much to control.

Dr Ducournau: Not if you are working with a flow controlled machine. A peristaltic pump, for example, eliminates a certain quantity of fluid, whatever the pressure in the eye. This is to say that the rollers slow down the natural outflow of the liquid. This is the thing that the venutri pump cannot do. We are speaking of a real flow control machine using a linear flow control with a maximum flow and a vacuum limit, but we don't care about the vacuum.

Dr Prünte: Which means peristaltic is actually a linear control of the flow, not the vacuum.

Dr Jundt: Yes. It is actually how many volumetric units per minute you shift in the tube.

Dr Luff: And we choose volumetric units (flow) because you shift from one substance to another when you are cutting. We are not interested in removing BSS from the eye; it's what happens when you move from BSS to vitreous.

Dr Prünte: In a peristaltic system is it really possible to control flow at such a low level as 1 mL?

Dr Luff: Yes. That's exactly where you can control it. At low levels, the control is accurate, the higher you go, you plateau out.

Dr Gandorfer: At this point would we all agree, as regards core vitrectomy, that there is no difference in clinical terms between a venturi pump machine and a peristaltic pump? You can get rid of the vitreous with the new systems in a very short period of time. And only if you go to very high vacuum levels with 20G, then the venturi pump has a theoretical advantage, but that doesn't matter because what else do we want but to have five minutes to get rid of the central vitreous?

2 Posterior Vitreous Detachment (PVD)

According to Dr Gandorfer the next step for him is always posterior vitreous detachment: "Dr Luff, can you comment, because that is a critical step during vitrectomy?"

Dr Luff: This is all about safety. We all know what we are trying to do: we are trying to grab hold of the vitreous cortex and induce a separation which will take a varying amount of energy depending on the age of the patient and the pathology.

The time when the mind is really concentrated is when we are teaching. When you are teaching you are suddenly made aware of how much you do know and what experience you have and how difficult it can be for new trainees. What worries me always with a venturi system is what happens when you let go of engaged vitreous. We start by turning off our cutter and deciding where we are going to aspirate and, perhaps, most people start nasal to the disk, as this seems to be a safe area, and it's then a question of deciding, with a venturi system, how much aspiration you can induce on the basis of what will happen when you break that occlusion and it lets go and you get some form of surge and collapse. If that happens very close to the retina there is a worry that the retina will come forward towards the probe.

So, while I feel very confident working with a venturi system inducing a PVD, increasingly if I had to teach I would say that I would always use a peristaltic system because of the consequences of what happens when you have an occlusion break. In terms of attaching to the vitreous there is just a moment of patience required. The venturi guys, like me, are used to hitting the pedal, the vitreous engages and that was that. With the peristaltic pump, you have to wait for the pressure to build up, you have to wait for the noise to change and you teach the juniors to start lifting the gel away at that point.

The bottom line for me is that a peristaltic system is safe because of what happens when - and this usually does happen for most people - you lose your grip on the cortical vitreous at some point.

Dr Gandorfer: You mentioned the rebound effect from the acoustics?

(Note: In a peristaltic pump the vacuum will increase as soon as the cutter tip attracts vitreous. An acoustic signal indicates this state. Surgeons can 'hear' the vitreous.)

Dr Luff: Yes and this is much better than the standard venturi approach which is to teach people to have someone watch the bag if you are using a gravity feed and if the bag stops dripping and you have your foot flat on the floor, you know you have cortical vitreous in the tip of your cutter.

Dr Das: I start by cutting the vitreous section with aspiration at something like 300 to 350 mmHg. I go close to the optic nerve and start holding the vitreous cortex. In the younger guys it requires normal time and higher pressure compared to the older ones, but I find it difficult when there is a detachment so that I don't cut into the retina.

I changed to peristaltic about two months ago. I have not measured it in absolute numbers, but I have found peristaltic is simple in terms of conducting a vitreous detachment without causing a mishap, although once you have the vitreous in hand it doesn't make a difference.

Dr Chawla: Safety remains the major concern. My feeling is that with a vacuum setting of about 250 to 300 mmHg one is safely able to create a PVD around the nasal side of the disk. Once you have lifted a little with the suction the flow tends to spread through the ring and back. I like to just go a little beyond the arcade with the vitreous detachment and then start the cutting. I am very careful about any iatrogenic breaks or any undue traction at any point. The cut rate is reasonably high at this point, it can go up to 2,000 or 2,500 and it becomes a very safe procedure.

Peristaltic, I feel, does tend to give you a better hold, once you have got the vitreous ring into your port, it's more like a forceps' effect, as compared to venturi. This is the feeling I have had over the last few months when I have been using it.

Dr Gandorfer: This is the experience of other surgeons too. Still there is a general belief that a venturi pump system makes it easier to get the vitreous into the port and that is definitely not true.

Dr Prünte: I am still using venturi, but I have been playing around with venturi and peristaltic pumps for about eight months. I had been using venturi exclusively but now I try to use both. After that my conclusion for core vitrectomy and vitreous detachment and posterior detachment is that I am still working with the venturi because I have the feeling that it is easier and faster to get the opening occluded by the posterior vitreous with the venturi pump and then to lift it off.

I totally agree on the fact that there is a safety option with the peristaltic pump and it is easier for less trained surgeons, because it gives you this acoustic signal when you can start to lift off the cortex when it is occluded and of course it is safer if you use the flow settings to avoid complications.

I think all of us have experienced detached retinas with attached vitreous which is maybe one of the most challenging problems we have. It's extremely difficult to work with this. When I start detaching the vitreous, I go close to the mid periphery and if you do this sometimes you see that it does not continuously proceed, then you know where your problems will be. I do it to the mid periphery then start cutting again, do my core vitrectomy completely then start to peel off the vitreous more and more to the periphery, if I need the anterior vitreous to be removed.

Dr Ducournau: As far as indications are concerned, I separate only when I am doing a core vitrectomy, for macular holes for example, so I don't do the PVD with my cutter because I don't want to induce traction in the periphery. I think this is a good solution to avoid tears at the vitreous base. But when we are talking about a complete vitrectomy, when the vitreous is sick - retinal detachment, inflammatory cases – I make the vitreous detachment with my tip.

I use peristaltic. The attraction of the vitreous is exactly the same if we use peristaltic or a venturi pump because there is no difference with the gradient of pressure. But the difference with the peristaltic is that when you attract the vitreous, when it is on your port, you can use 600 mmHg of vacuum and this is not possible with a venturi pump. That would be too dangerous, as has been said. So, you have a higher efficiency, with a higher grasping effect, with the traction that you can induce.

Dr Gandorfer: This is a critical point. The advantage of the peristaltic pump is that you can apply high suction vacuum and very low flow. You can control the flow at the minimum level needed to engage the vitreous.

Dr Prünte: What I don't understand is the reason why you cannot create the same vacuum with a venturi pump compared to a peristaltic pump?

Dr Jundt: It is true, you can create the same vacuum. But when venturi is set to a high vacuum, it becomes very difficult to keep the flow at a low level. If you set it to 600 mmHg as mentioned before, a small pedal deflection will already create 100 to 200 mmHg and a corresponding flow of 10 mL or so. In peristaltic you would set the flow to 10 mL and can control it at 2 or 3 mL with a small pedal deflection, yet the vacuum is still below 100mmHg and increases to higher values only upon occlusion, giving good grip. This might also be the explanation for the forceps effect mentioned by Dr Chawla .

Dr Gandorfer: Looking at the comparison between venturi and peristaltic on vacuum build up time there is also this general belief that with a venturi system there is a quicker response and the vacuum rise is faster. But again is this true?

Dr Jundt: It is true that the venturi pump can be faster, if you take for instance the 500 mmHg limit, venturi can reach it in 0.6s whereas the peristaltic needs 0.8s. But this is with the cartridge almost full. The venturi pump needs to take off the air that remains in the cartridge. So, when you start a surgery with an empty cartridge, it is the opposite. So, there is no general rule for saying venturi is faster or peristaltic is faster. It depends.

Dr Gandorfer: In clinical terms it is definitely the same. We won't notice the difference between 0.6s and 0.8s at a level of 500 mmHg or so.

Dr Luff: You are occluding the tip here and that's not quite what happens when you are operating, especially when you are training people; they are going to stay away from the cortical gel. The reason, it seems to me, that a venturi is faster is because you have to induce a high flow state to somehow create turbulence to get the material into the tip. The only thing I think that doesn't apply is if you change your cutter for an end aspirating instrument, then you can put the instrument with the tip facing the gel. Any side cutting port is a compromise when you come to try and face the cortical gel, especially when you are training. The trainee is apprehensive about approaching the retinal surface, but that's where the gel is!

Dr Jundt: But there is no difference in the vacuum build up?

Dr Luff: No. I am talking about the time it takes for the gel to get there to occlude the port. Once the port is occluded, I can't argue that there is any difference at all. But, if you are above the cortex you may need high flow based turbulence to get gel into the cutter port to occlude it before vacuum build up starts.

Dr Jundt: This depends on the flow within the eye. There is no difference between the two pump systems for taking off particles to come to the open cutter, provided they work at the same flow rate.

Dr Luff: I change my flow from 40 to 4 mL when I am going to work over the gel, at that point I feel that there may be a flow-based element to how quickly gel engages with your cutter, because we are using a side port and we don't always get as close to the cortical gel as we should. If you have the confidence to work close to the retina and engage cortex directly flow rate shouldn't matter.

Dr Jundt: That's true but the reason you go from 40 to 4 mL is because I guess it's safer. If not you could go back to 40 mL.

Dr Luff: I don't, but I am making the theoretical argument that there is a difference between the unoccluded and the occluded cutter. And we do not start with a completely occluded cutter.

Dr Jundt: But if one compares the two pumps, one must apply the same parameters. One cannot just take 1 mL per minute for the peristaltic and 600 mmHg for the venturi (which results in 23 mL of flow in an unoccluded 23G cutter) and say "a peristaltic pump is slower."

Dr Luff: I am not going to argue physics with a physicist, but I think there is in general a feeling that there is just this moment when you are waiting for something to happen with a peristaltic pump and you are not with a venturi. Also, I think it has something to do with the gel engaging with the port. On a practical level, it makes no difference.

Dr Prünte: This is extremely important. We are now discussing pure physics and most of these measurements are done in fluid without irrigation, not in a closed system.

With a procedure, which every one of us may do differently, this may have an effect on the workability of the vitreous. For example, you start somewhere in the cavity after a core vitrectomy, create some flow and go closer to the vitreous to try to attach it. What I do is go very close to the retina and then start the procedure by adding vacuum. This is a completely different approach.

Dr Luff: This is a great example of how an experienced surgeon will do this more safely, because you dare to go close to the retina. If I am training juniors, the way to get them close to the retina is to put a bit of triamcinolone in so that they can see where they are going. Otherwise they haven't got the confidence to do it.

Dr Gandorfer: That is very true. The approaches can be so different and the machine settings very different. Then the surgeon comes to the conclusion that the peristaltic pump is not as fast as the venturi pump, and that is perfectly right in their mind.

Dr Prünte: Not just in his mind. I still believe it is right under this particular condition of the procedure. It is the experience of the surgeon, because he does it in his special way. Maybe there are situations where one pump works better and other situations where the other is better.

Dr Jundt: Apparently surgeons prefer different settings for the two systems. Same settings for instance would be venturi at 300 mmHg and the corresponding peristaltic flow setting 15 mL (**see graph**). Now you will have the same flow with which you attract the particle towards your cutter. This is independent of how you do it, if you go further away from the retina or if you come close. But with the peristaltic pump you can control the flow more carefully. You can closely imitate a venturi pump with a peristaltic pump, but not *vice versa*.

Dr Ducournau: At the very beginning, twenty years ago, the peristaltic pump was built to provide a very low increase in flow. When Storz built the first venturi pump, people found that the increase of vacuum was higher with the venturi pump. Why? Only because of settings! If you want a peristaltic pump to make an increase faster than with a venturi it is very easy to do that. Just increase the flow rate.

And this is why the peristaltic pump is more effective, more efficient, because you have a block of aspiration flow at 10 mL and even if you have a rupture in pressure when you have minus 600 mmHg you will go at 10 mL, you will not reach 25 mL.

Dr Prünte: Yes, but I still believe there is a surge problem with peristaltic, because the system cannot regulate as fast as we would like. And so the surgeon's experience comes into play again.

I totally agree that peristaltic has a much larger safety limit, which is much better for trainees.

Dr. Jundt: We can confirm this. Our measurements show no significant difference regarding surge after occlusion break between peristaltic and venturi. We know this from phaco. However, with cutters having comparably smaller openings than standard phaco needles, surge after occlusion break is less of a problem in VR surgery.

Dr Chawla: What is the mechanism that is regulating the sensitivity of the peristaltic pumps, which makes them behave more like a venturi pump at a particular setting? You have that control in the OS3 where you change the sensitivity of the venturi pump to 70 or 75 percent?

Dr Jundt: With the venturi effect function on the OS3 the time to build up venturi vacuum is electronically delayed. On the peristaltic pump you can reduce the time to build up vacuum by increasing the flowrate setting. At 40 mL the two pump systems are equally fast.

Dr Chawla: What has been the major difference in the evolution of peristaltic pumps from the time they started to the present day pumps? Is there a difference?

Dr Ducournau: At the very beginning when you were aspirating, each time the rollers were attacking the tubing it was inducing a small reflux. This is why the aspiration was uneven. On the latest peristaltic pump, this peristaltic effect is eliminated.

Dr Jundt: To judge the peristaltic effect, we measured the stripper sucking BSS. The measurements show 1 to 2 mmHg variation. Some years ago it was much more, you could really see it was going back and forth. At the levels of intraocular pressure used during VR surgery, a fluctuation of plus or minus 1 mmHg is negligible. If you move instruments and tubing you will have that at least.

Dr Gandforfer: I think we can say that the peristaltic effect has been technically overcome. To summarise comments on PVD, the peristaltic pump does show a broader margin of safety and that is especially important for training.

3 Vitreous base shaving and removal of the peripheral vitreous in cases of attached retina

Dr Das: I go to a cut rate of 2500 to 2000 be safer. By this time I assume that I have done my core vitrectomy and completed the PVD. I found it safe to do a very high cut rate with flow rate and aspiration matching the cut-rate system. I have found it is safer to do a 23G base vitrectomy compared to a 20G; that's because I can shave the retina better with 23G than 20G.

In 20G I have also tried using the Innovit cutter and have found it was better than the Accurus cutter.

In my experience, doing a base vitrectomy between 11 and 1 o'clock is more difficult than other areas because you can't see as well.

I raise the bottle height when I do a base vitrectomy, depending on the patient's requirement – I don't have a mathematical calculation. I either use my own foot pedal or ask my nurse to change the bottle height and it is certainly higher than what I would use compared to a core vitrectomy or inducing PVD.

I have used venturi for a long time, before the recent change to peristaltic. In a detached retina, vitreous base surgery is relatively simple with a peristaltic pump. Attached retina is similar, there is not much difference.

Dr Gandorfer: Why do you raise the bottle height?

Dr Das: Because I also increase the flow rate and the vacuum and the eye must not become hypotonic while I am doing the surgery.

Dr Chawla: I have been mostly using very low vacuum settings for base excisions, with high cut rates. My vacuum settings are in the range of 50 to 70 mmHg on the peristaltic and on the venturi pump, with the cut rate at 2200 to 2500. For the superior area, between 11 and 1 o'clock, I use a non-contact system and have the assistant depress. The rest of the area I am able to do quite well with a direct depression, under the microscope even.

I have been training myself to use the peristaltic pump more – I felt I was getting less breaks in the periphery. Not so much with an attached retina, but definitely in the case of a detached and mobile one, I would be more inclined to use a peristaltic pump

I feel this is one area where peristaltic pumps need to be investigated more and may offer an advantage. How and why? I feel we need to learn about the behaviour a little bit more, we need to study it, we need to work on it.

Dr Prünte: After my eight months experience, this is the indication where you have me on your side. My standard approach now is peristaltic for peripheral anterior vitrectomy. I use both systems in the same surgery – now I need both pumps in my OS3 system.

I don't make any changes to the settings for attached or detached peripheral retina. One possibility is to do core vitrectomy and leave the anterior vitreous, which I do in many cases. But if I decide the anterior vitreous has to be done it has to be done as completely as possible, and my settings are high vacuum - I still have 400 mmHg vacuum – but a very low flow, maybe 4 or 5 mL.

Dr Ducornau: I have the same philosophy. If we must make a complete vitrectomy it should be as complete as possible. At that moment I select a second programme that I have set up on my machine where the vacuum is as high as in other cases, I don't really care about the vacuum, but the maximum flow is 6 mL. So I have the full course of my foot pedal from zero to six and I can select precisely the level of aspiration flow that I want.

I work with a very low cutting rate. My philosophy is to attract the fibre, not too much at a time. It is almost cut by cut. Most of the time I use 60 cuts a minute, or less and I am working with an aspiration flow of 1 to 4 mL per minute.

I profit from this to complete the peeling of the post hyaloid up to the base of the vitreous, in case it was not done completely by the PVD discussed previously. I cut, cut by cut, all the remnants of the fibres.

Dr Gandorfer: You are depressing the sclera.

Dr Ducournau: Yes, but by myself, I do it with a slit lamp on the microscope so that my left hand is free to make a scleral depression.

Dr Luff: I think we are all saying the same thing. We're looking for safety. We're looking for control. If you are using a venturi system, the way to get control is to effectively decrease the efficiency of the system, using the cutter rate to slow the flow. This was used by Alcon in the Constellation deliberately I think, changing the duty cycle to slow the flow at very high cut rates.

As far as safety goes, bimanual surgery and indenting make a massive difference, particularly with detached retina. The difference between the way retina behaves when it is sitting on a concavity compared with a convexity is massive. You also have the option with the 23G system, where the three trocars are the same, to move around. You can move your light port; you're never stuck with a blind area.

For me, this is the moment when a low flow peristaltic pump comes into a class of its own.

Dr Durcournau: What cutting rate are you using?

Dr Luff: If I am using the Oertli machine, I will keep the cutting rate fairly high, because I feel I can control the flow, until I come to material which is solid. If I am trying to dissect some kind of fibrotic change in a chronically detached retina, then I would put my cut rate way down, perhaps not to sixty, more like 120, two cuts a second. So the moment the material becomes more solid then yes you get the control and the efficiency of the cutter by slowing the cut rate.

Dr Gandorfer: I was operating in exactly the same way as Dr Ducournau; apply suction and cut it off with a very low cutting rate using a peristaltic pump. Then I changed about a year a go to a higher cutting rate on the 23G system, because I felt comfortable controlling the flow on a very low level. I didn't change my settings on the machine, they are still 12 mL, but I apply very low suction and that works quite well.

So, you can go up to rather high cutting rates and, my impression is that the traction generated on the retina is less. I don't know whether we can rely on it, but you can see the retina, in cases where it is mobile, is fluttering less.

4 Vitreous removal in cases of mobile retina

Dr Gandorfer: In the case of a detached retina, would you make any change in your settings?

Dr Das: I reduce my aspiration flow level, although not as low as Dr Chawla talked about, but certainly lower than I would normally have it so that my retina is not caught accidentally in the vitreous cutter. Flow rate comes down, but cut rate remains high. Often with a detached retina, to get a firmer base, I depress the retina periphery so that the area becomes convex.

Dr Chawla: Depression definitely has a stabilising effect. All of us seem to agree that if you have condensed sheet-like vitreous in detached retinas, where it is attached to the vitreous base or to the margins of the lattice, you definitely have to come down to very low rates to remove that kind of sheet.

A 23G cutter will give you a more controlled removal of the sheet to the points where it is attaching to the detached retina. I think more of our peripheral base surgery and primary vitrectomy should shift toward 23G because of the cutter advantages we are getting and the advantages of getting closer to the port tip. There are 20G cutters being developed with closer tips, but I still feel a smaller gauge with more control on the aspiration levels would make a difference to the stability of the whole procedure and mean less iatrogenic breaks.

Dr Prünte: I almost have the opposite approach to Dr Gandorfer with low flow rates and high vacuum rates, but with high cutting rates, I routinely use 3000 cuts per minute, even for the shaving of the retina particularly if it is attached. If it is detached, of course if you have solid material like haemorrhage or PVR then you have to decrease the cutting rate because otherwise it gets completely inefficient and particularly when I see localised attachments of the vitreous. This is usually found in the region of a break, but also during vitrectomy you find some areas where the vitreous is attached more strongly and then I go down with the cutting rate and try to clean this from the retina. I think this is an area of risk, post vitrectomy.

In these cases, with detached retina, I find myself more and more using the dual-linear foot pedal, which is a real advantage. I may not use my complete flow, but definitely different cutting rates and this is the advantage of the multi-linear pedal.

Dr Gandorfer: With the technologies we have and the dual linear foot pedal, it has become much easier to get the control into the arm, because you can switch the cutter to a high rate and then apply suction very safely.

Dr Prünte: Which is wonderful on a detached retina.

Dr Ducournau: A detached retina can be different if it is very mobile, giant tears for example. In a normal retinal detachment, the retina is attached so it is less mobile. Also the density of the fluid behind the retina produces a kind of attraction force so it prevents the retina from moving too much. If you induce a force, a little higher, you can attract the fibres and cut them. If you have a giant tear, the retina is not fixed and the liquid is the same density throughout, so the retina is very mobile. There is no attracting force of the retina so you must work with a very, very low flow.

This is why I would like to suggest that Oertli develops a control for the aspiration flow not 1 mL per 1 mL, but 0.1 mL per 0.1 mL. I have had the occasion to work with a machine that allows that, I will not say the name, but you can go from 1.1 to 1.2 to 1.3 and that gives you this incredible feeling of aspirating exactly what you want, to attract the fibres slowly, just as you want without making the retina move.

In special circumstances, where the retina is very mobile, without the liquid behind, we have to learn to work with a very low and precise flow.
(Note: The Oertli faros™ surgical platform actually offers 0.1 by 0.1 mL flow control.)

Working with a very low cutting rate will allow the vitreous (around the lens) to be pulled down without touching the lens. When you aspirate without cutting, this vitreous is attracted and, then, you can cut it. If you cut at a high speed, the vitreous will remain fixed and to remove it you will be forced to remove the lens.

Dr Luff: Shaving gel over a detached retina is an operation that I best perform at a bar after a good meal really – I can talk about it for hours, doing it is a different thing! I always ask myself very carefully do I really need to be shaving over a detached retina? I do my best not to have mobile retina so I put heavy liquids in. I know I lose the stabilising effect, but I put the heavies right in there and I'll be cutting right along the edge of the heavies.

I struggle with the physics, but there is an effect, I think it is the Bernoulli effect, that says as the material gets very close to the port, the rate at which it moves towards the port suddenly increases. So, how do you avoid that? I just think you try to stabilise the retina and I will try to peel a piece of gel from the periphery and then cut it. But this is the most difficult thing to perform as far as I am concerned.

I totally agree that a low flow state is the best we can have and the more control you have over that low flow the better.

5 Removal of epiretinal membranes

Dr Gandorfer: Has the cutting rate or other developments changed your treatment and your strategies in diabetic cases?

Dr Das: I am fond of using 23G for diabetic patients. It helps me not to use a variety of other instruments. I don't have to change from forceps to scissors to do a segmentation or membrane peeling. I have given up dissection en bloc because it's technically too difficult. I go between segmentation and peeling. 23G helps me do both, almost. Occasionally, I might use forceps, otherwise 23G works. I like to use a high cut rate so that I can go as close as possible to the vitreous membrane. If the membrane is sitting right on the optic disc I like to pull it up first with a pair of forceps, just enough to get the right plane and once I have the right plane I can keep cutting.

I use diathermy several times to stop bleeding and use very small bubbles of liquid to stabilize the retina when I start to go towards the periphery. With the initial steps of core vitrectomy, posterior vitreous detachment, you cannot create much air unless you go to the level of the membrane, but this kind of surgery is very different from epiretinal membrane surgery, there things are certainly easier. I will use forceps to peel off the membrane and come out very quickly without putting in any air or gas.

But diabetes is a problem. With most diabetics I will put in oil or gas, usually gas, occasionally oil. I don't know what happens in Europe, but we admit the patients in India for at least a day, to teach post-op positioning and also because we feel it's safer not to send them home immediately. Now that we use Avastin (intravitreal bevacizumab injection) ten days before the surgery the bleeding rates have come down during surgery and post op. Surgical time has reduced because we don't have bleeding during surgery.

Between venturi and peristaltic, I did not initially find a big difference between the two, but slowly I have learnt that peristaltic is relatively safer than the venturi even while working in the inner vitreous.

Dr Gandorfer: So, the new high speed cutting systems save time and instrument changes?

Dr Das: Yes. In India we talk about the cost of surgery. 23G cutters are more expensive than 20G cutters. But suppose I do not use a pair of scissors; then the cost is actually less. A 20G cutter plus scissors is more expensive than a 23G cutter.

From a safety point of view, as I don't have to change my instruments again and again, sclerotomy-related complications are less. With newer systems where there is a self-sealing valve there is no fluid leak whenever the instrument is changed. Only once, my valve ruptured but I have now worked out how to respect it.

23G vitrectomy in a diabetic patient is to my mind more predictable.

Dr Chawla: With reference to diabetic vitrectomy, that is a major problem in our country, simple epiretinal membranes are happening all the time and we are taking care of them. If I am dealing with a taut posterior hyaloid membrane epiretinal complex, it's a simple surgery with 23G. Any simple diabetic vitrectomy, fibroblast prolif at the disc with few attachments, just a single 23G cutter with high speed, a good vitrectomy, and that's it. But when the situation gets more complex, when I am dealing with a bad tractional detachment, I don't want to create iatrogenic breaks. It's still a 23G surgery, but a bi-manual surgery with one 25G chandelier at six-o'clock, non-contact viewing system and a dissection. While I am doing the dissection I come on to a normal contact lens system.

Most of these patients have not had photocoagulation, they maybe receive Avastin, but my Avastin wait times have come down. I operate on the patient on the fourth or fifth day after Avastin, I don't like to wait longer.

I find results very predictable. The only thing I'd say is that some patients do require a repeat vitreous wash out after a few days. That's the only problem we are seeing. Normally a single lavage is sufficient.

Dr Gandorfer: In which cases are you using oil?

Dr Chawla: I use oil in very few diabetics. When I do use it they are mostly bad tabletop detachments. I do two stage surgery many times where I remove the vitreous gel at the first go, remove the membranes quickly with a bi-manual dissection, put in Avastin and air, wait four or five days and then go in again and do a clean up. I then assess whether I can get away with sulphur hexafluoride, air or I need silicon oil.

This is the standard approach with diabetics, and a major number of vitreous surgeries in India today are for diabetics.

Dr Gandorfer: What percentage would you say?

Dr Chawla: Close to 35 or 40 percent.

Dr Das: Nearer 50 percent. Half of them will be for diabetes, another 30 or 40 percent for detachments, very few for epiretinal membranes. The reason is, patients tend not to agree to membrane surgery if the fellow eye is doing well, if they are in old age and they are not very concerned about the quality of vision, only the quantity of vision. Conversely, with macular holes, they agree faster to surgery than with just epiretinal membranes.

Dr Chawla: The patient is more convinced with epiretinal membrane surgery when they get two or three plus nuclear sclerosis. And for a combined procedure they are more willing. As surgeons we give them the advantage.

Dr Prünte: In my experience the advancement in machines, with better control, small incision gauges and cutter design, has changed a lot in working with epiretinal membranes. We can do a major part of the membrane work with the cutter now, compared with earlier when it was bi-manual. I rarely go to bi-manual.

But this needs an extremely flexible approach to adjusting flow, vacuum and cutting-rate. This is the second big advantage of the dual-linear foot pedal because you have to vary suction rates and cutting rates all the time. Today with a 23G cutter or a 25G cutter you can trim down membranes to the vessels of the arcuate. This is one of the most impressive changes in vitrectomy during the past years.

On the other hand, for me, the cutter design provides some great possibilities for improvement.

Dr Ducournau: In France we have very few diabetics; less than 5% of patients that present will be diabetic. It is a question of diet.

I would use my cutter as previously described. In case there is some bleeding, although there is much less bleeding than when you use scissors or forceps, I use aspirating diathermy. This is a very useful thing for diabetes so you don't have to aspirate the blood and change to make the diathermy. You increase your aspiration flow until you have entirely aspirated the blood and at that moment you push on the other side of your foot pedal to increase the diathermy and block the bleeding vessel.

Dr Luff: The British are not as healthy as the French I'm afraid!

A few things have made a difference. Clearly Avastin has made a huge difference to severe cases and I wouldn't go near a severe diabetic without Avastin these days.

I suppose, in a nutshell, what you have with a 23G cutter is a multi-modal instrument. You can aspirate the blood, you can use it as a pair of forceps, you can manipulate tissues very carefully and you can cut fast or slow, however you do it; you can do all kinds of things with that cutter. I have been moving towards bi-manual surgery, I have this wonderful chandelier but I find I need it less often.

If you are prepared to change hands and use the third port you can come at membranes from a different angle and you can often make your life much easier.

6 Combined Procedures

Dr Chawla: I was attracted to this surgery when I first observed it being done in the Singapore National Eye Centre. I did a fellowship with them in 1994 and I saw that they were doing a large volume of these cases where they were combining phacoemulsification with vitreous surgery. It was all 20G at that time.

When I came back it got me thinking, when I have a patient with one plus nuclear sclerosis, I realised that a lot of patients who undergo vitrectomy for diabetic proliferative or non-proliferative disease, tend to have an increased incidence of cataracts within two years. I thought, looking at the economic issues in our country, it was worth doing more combined procedures. At that time the thinking was you remove a lens and wait for two months before doing a vitrectomy, or vice versa.

Once we started doing it we aimed for better ablations using both the endo-laser and the laser indirect ophthalmoscope on the periphery, doing a complete ablation - that was before Avastin came in.

We were extremely careful and the results were good. We were addressing everything at one go, we were getting a better visualisation for epiretinal membrane surgery. It made sense. It was controversial in the beginning, but it has been a good journey and with Avastin coming in it has been even more interesting.

Combined procedures have become, even in complex eyes, much safer.A complete job and a complete ablation is very important to have a stable effect and a happy patient, if by the end of a week or 10 days they are able to see 60/60 or 6/36 even, that's reasonable visual improvement. You have a better chance of assessing them later on with an OCT or repeating an angiography and addressing the macular problems separately if you need to with drugs.

Dr Gandorfer: Are there any obstacles to combined procedures?

Dr Prünte: I have been a great advocate of combined procedures for more than 15 years. It's a good way to go. You have to consider that we induce cataract anyway, sometimes cataracts disturb our view or our procedures and you never have better access to the anterior retina than in an aphakic eye – this is why I always do the implantation last.

Usually, after a vitrectomy, an aged lens is going rather fast into a cataract stage and this disappoints patients and disappoints us for diagnostics. I really see a strong case for combined cataract and vitrectomy surgery.

What I do, particularly in detachment cases if it is a young patient with the possibility for accommodation, I consider a non-vitrectomy approach to the detachment because otherwise it will damage the lens over time. It is only in little children that you can hope that the lens is going to be clear for many years.

Dr Ducournau: I think this is a very complex subject, because it takes a lot of things together. First is the quality of the vitrectomy. If the vitrectomy is complete this means there will be a large number of cataracts. If you perform only a core vitrectomy, as we do with membranes, I have statistics on 2500 patients with a follow up of five years and the number of cataracts was only 62 percent. So, in the cases where you perform a core vitrectomy, doing a systematic phaco is condemning 38 percent of the patients to an unnecessary trauma. Second, in France the only people performing combined procedures are professors because the patient does not belong to you, he belongs to the referring ophthalmologist and so if you want this ophthalmologist to send you future patients, you have to respect their work and it is better not to touch what they are very able to do by themselves. The third is the cost. We saw in the second EVRS meeting that in Germany at that time, 2002, the cost of a combined procedure, what the doctor received was greater than the additional cost of two procedures. This explains why there were so many combined procedures in Germany.

There are professors in France who say there is no additional inflammation, but everyday we see patients with macular holes with a bubble that have some adherence between the iris and the IOL. I don't think that it is completely atraumatic.

But there are cases where you have to perform combined procedures and with these I am happy with bi-manual surgery. I make a phaco through 1.4 mm. At the end of the phaco I don't put an IOL, I put a capsular ring, because if you don't you can catch the capsule. It allows you to perform the vitrectomy without ports, without sutures, so you have a waterproof eye. Only at the end of the procedure I will increase the opening to 2 mm to inject the IOL.

Dr Luff: In general terms, if I am going to put gas in the eye, I am always going to ask the question, "is this a good time to do the phaco?" All macular holes would have a combined phaco-vitrectomy, full stop. I would never consider not performing phaco on a macular hole. If you are putting gas or air into a detachment, the question is can you really assess that patient for an IOL?

When considering avoiding cataract by not performing a complete clearance, say for epiretinal membrane, I think you are looking at the psychology of your patients. Certainly some of my patients would be happy if I removed their membrane, but unhappy if I left them with floaters. They often ask will all my floaters go away at the same time? If you're going to do that you're going to have to do a more complete clearance. I'm looking at all kinds of factors with epiretinal membrane peeling including the age of the patient and how we are going to imbalance that patient with refraction? There may be times when there are obvious refractive advantages to performing phaco at the same time. With a unilaterally myopic eye, this is a great chance for that patient not to be unilaterally myopic anymore. So it really is horses for courses.

I have no worries about performing combined surgery and I think it is only when you do, you realise how much gel you leave in every eye that doesn't have combined surgery. If I have difficult PVR or a difficult diabetic I know that there is no way I can hope to get near a true anterior clearance in a phakic eye.

Dr Das: I like to combine macular hole surgery with cataract surgery. Unfortunately, I do not do phaco myself, so I need help from my colleague to do it and sometimes they are not free to help out. In a difficult detachment patient, PVR, D2 and D3, where I have to do cataract surgery, instead of doing a lensectomy and making the eye aphakic, I like to combine with my cataract colleague to do the phaco IOL and then I complete the surgery.

Invariably I do not combine lens surgery with vitreous surgery in a diabetic patient, unless it is a hard lens – with advance cataracts one can't avoid it. At the other extreme, with most macular holes, I will combine it with cataract. It is easy to do because one does not need extensive vitreous surgery. Thus, I play between the two extremes.

Dr Gandorfer: To conclude, I think of course we see extremes, but I think we all agree there are no real obstacles anymore to combined surgery.

Conclusion of the roundtable

"The peristaltic pump is equally well suited for VR surgery as the venturi pump. In situations like PVR, shaving of the vitreous base, removal of peripheral vitreous in mobile retina etc. the peristaltic pump even offers deciding advantages. These include higher precision and more safety thanks to direct flow control. Dual linear pedal control, valved trocar systems, appropriately selected cut rates between 1 and 50 per second all help to increase safety and precision. For training and on-the-job learning peristaltic is preferable. There are clearly now no obstacles anymore to combined surgery. "

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