Next-generation phaco increases chamber stability with precise fluidics control

Vacuum-flow hybrid pumps boost flexibility, new technology limits post-occlusion surge

Howard Larkin
in San Diego

LIVE vacuum, like that provided by venturi phaco pumps, is great when you're flipping or holding a dense cataract nucleus for pre-chopping or aspirating cortex. It's fast and powerful, pulling in and holding material at the touch of a pedal, making short work of tough tissue.

But when you're sculpting a nucleus or clearing out the last fragments inside the capsular bag, the gentler action of a flow, or peristaltic pump may be more controllable. It's slower to build vacuum, making it tougher to grab larger particles, but reduces the chance that you'll accidentally suck in — and possibly rupture — the capsule wall.

Until now the choice of one pump type over the other had to be made before surgery — and you lived with the advantages and disadvantages no matter what happened on the table. But the latest phaco systems from Advanced Medical Optics and Bausch & Lomb change that. For the first time you can toggle between venturi and peristaltic modes needed during surgery. This makes the power, efficiency and speed of live vacuum available when you want it, and the stability and safety of flow is there when you need it.

Both the B&L Stellaris, unveiled late last year, and the AMO WhiteStar Signature, introduced at the ASCRS meeting this April, deliver this enhanced capability using hybrid pumps that deliver peristaltic or venturi flow characteristics with no need for an external air tank. In addition, Stellaris offers a vacuum-only module, also requiring no air tank.

These next-generation phaco systems also employ a range of innovative mechanical and software-enabled technologies that reduce surges in intraocular pressure during surgery due to sudden outflows of fluid following clearance of phaco tip occlusions. Routinely damping surges could reduce capsule ruptures and vitreous face tears that can develop when the chamber abruptly shallows and the posterior capsule faces “trampolines”.

Integrating anti-surge and flexible pump technologies increases the power and precision of fluidics, potentially increasing not only the safety but also the efficiency of both coaxial and bi-manual phaco procedures, say the manufacturers and surgeons who developed these new systems. It is especially beneficial for micro-incision procedures, enabling increased vacuum and flow rates that improve the gripping performance and evacuation efficiency of smaller-diameter phaco tips without increasing surge risk. Increased flow and vacuum also reduce the phaco energy needed to emulsify fragments, reducing the risk of burn, corneal oedema and endothelial cell loss.

Both AMO and B&L emphasise the central role of increased fluidics power, flexibility and control in minimally invasive cataract surgery. They're even branding their fluidics technology: B&L calls its system EQ Fluidics; AMO refers to its approach as Fusion Fluidics. Both incorporate and build on previous anti-surge technologies, and are integrated with the latest phaco power modulation and cutting technologies.

These fluidics advances are said to enable quicker cataract surgery through smaller incisions with less phaco power. Not only could this reduce complications and improve patient outcomes, it may facilitate development of the precision micro-incision procedures that will increasingly be required to meet the exacting demands of the growing field of refractive cataract surgery.

Bausch & Lomb Stellaris with EQ Fluidics

Bausch & Lomb markets its new Stellaris phaco system as part of a comprehensive suite of products for micro-incision cataract surgery. These include lenses, instruments and phaco tips designed for coaxial and bi-manual procedures through sub-2.0mm incisions, including a new 1.8mm coaxial tip to be released when Stellaris begins shipping this summer. Instructional programmes in micro-incision techniques also are offered.

Stellaris incorporates several new features to increase overall efficiency and flexibility. Physically, it is compact, portable and easy to set up. It has a high-definition touch screen interface that provides step-by-step illustrated instructions for setting up the machine, making it easy to train new support staff. Streaming video makes it possible to monitor surgery via the screen, eliminating any need for a second microscope. Cassette modules snap in, reducing the time between surgeries and facilitating future technology upgrades.

Bluetooth-enabled wireless foot pedals and remotes provide control with fewer cables cluttering the floor. The system currently provides voice confirmation of input changes. Voice control is a planned enhancement. These features reflect the input of surgical support staff as well as surgeons, B&L says.

Several new features that enhance the power and precision of vacuum and flow while improving chamber stability are referred to collectively as EQ Fluidics. EQ stands for equalisation, referring to the need to balance inflow and outflow to maintain chamber stability.

“The whole machine is designed from the ground up to work together as a system”

Uday Devgan MD

“The whole machine is designed from the ground up to work together as a system,” Uday Devgan, MD, of UCLA Medical Centre and the Maloney Eye Institute, Los Angeles, US, told a seminar at the 2007 ASCRS Symposium on Cataract, IOL and Refractive Surgery.

Non-compliant tubing is one feature that helps suppress surge. Use of more-rigid materials and thicker walls prevents aspiration tubing from deforming when vacuum rises due to an occlusion, and then snapping back when the occlusion breaks and momentarily sucking fluid out of the chamber. Outflow stability is further enhanced by a micromesh filter in a segment of larger diameter tubing in the aspiration line followed downstream by smaller diameter tubing. The filter prevents particles from clogging the aspiration line, allowing vacuum and flow to be maintained at a constant — and higher — level governed by the smaller diameter tubing, increasing gripping power and flow. A bypass valve that opens during surges to pull fluid from the bottle instead of the anterior chamber also helps prevent sudden IO P drops.

Advanced software and sensors also contribute to surge suppression and fluidics control. Vacuum thresholds, rise times and duration at high vacuum before powering down can all be set by the surgeon depending on surgical style and the needs of the case. This helps prevent vacuum from rising and staying too high due to occlusion, reducing surge when the occlusion breaks. With the EQ Fluidics advanced flow module, it also allows the surgeon to select either flow or vacuum pump characteristics, and choose vacuum and flow rates suitable for each step of surgery. For example, flow characteristics might be used for sculpting, followed by vacuum for segment evacuation. Sub-modes for example allowing higher power for harder nuclei, can also be pre-programmed, providing flexibility to respond to case needs as they arise. The touch-screen interface allows instant switching between modes, adjusting all fluidics and phaco power settings.

The result, says Dr Devgan, is a system that is subjectively more responsive in gripping power and followability that delivers objective improvements in chamber stability. Data he presented showed that post-occlusion surge averaged just over seven per cent with the Stellaris using a flow module in flow mode, and 1.09 seconds in vacuum mode, compared with 8.5 per cent for the Millennium system. Return to steady state IO P post-occlusion was also much faster for the Stellaris, averaging 1.25 seconds for the flow module in flow mode and 2.01 seconds in vacuum mode, compared with 2.01 seconds for the Millennium, providing objective evidence of improved responsiveness. The variation in surge
levels and return times were also much less with Stellaris, suggesting more predictable response.

In addition to innovative fluidics, the Stellaris features a new ergonomically designed hand piece with a longer cutting stroke and improved ultrasound focus and resonance for enhanced cavitation and quicker emulsification. Overall, Stellaris offers less surge and better responsiveness all around, Dr Devgan said.

"It is very stable, even with a larger phaco needle."

**Advanced Medical Optics WhiteStar Signature with Fusion Fluidics**

Advanced Medical Optics positions its new W hiteStar Signature with Fusion Fluidics as offering flexible new capabilities to minimise surgical trauma by reducing phaco energy and post-occlusion surge. This is done by integrating advanced fluidics management that allows higher vacuum and flow with greater chamber stability, and enhanced micropulse technology that increases emulsification efficiency. The system is designed to support both existing and anticipated coaxial and bimanual procedures using a variety of current and emerging surgical techniques, particularly micro-incision approaches.

Signature is designed for efficiency in the OR, featuring a compact footprint and access to pre-programmed fluidic and phaco power settings through a touch-screen interface. Snap-in tubing cassettes enable quick turnaround between cases with reduced chances for set-up errors. Wireless foot pedals and remote controls are in development, and voice confirmation of commands is optional. The system also allows continuous taping of procedures with power parameters and trends overlaid using specialised media software that enables detailed continuous analysis for case review and teaching.

The heart of the system is a dual pump and peristaltic flow controlled by Fusion Fluidics management. Fusion Fluidics incorporates what AMO calls advanced chamber stabilisation environment, or CASE, to reduce post-occlusion surges. "It's like ABS brakes, you don't have to think about it," said David F Chang, MD, clinical professor, University of California-San Francisco, US, who consults with AMO and has done about 75 procedures using the Signature platform.

First introduced with W hiteStar ICE, CASE has been enhanced for the Signature platform. It monitors vacuum levels, and when a pre-determined threshold is reached, backs up the pump as quickly as 26 milliseconds to reduce vacuum to a second, lower, pre-set level. This has been shown to reduce post-occlusion surge by 56 per cent with a 20-gauge tip compared with the same setup without the automated controls. "This allows use of higher vacuum and flow rates without risking chamber instability, and makes it possible to use smaller tips on hard nuclei without sacrificing speed and efficiency", Dr Chang said.

"CASE is what I call an anti-surge algorithm", he said. "We want very high vacuum to grip a nuclear fragment, but to avoid post occlusion surge we would then want a much lower vacuum level at the moment that ultrasound clears the phaco tip", Dr Chang explained. "CASE tries to automate and duplicate what an experienced surgeon does with a dual linear foot pedal when the tip becomes occluded – backing off of vacuum before increasing phaco power in anticipation of an occlusion break".

Fluidics parameters can be integrated with W hiteStar micro-pulse control settings to meet the demands of varying surgical conditions. Dr Chang predicts that surgeons will love the ability to toggle between a peristaltic and Venturi-style pump during the same procedure. "When impaling the nucleus for chopping or pulling out the first quadrant, live vacuum will do a better job of drawing epinucleus and cortex to the tip."

Dr Chang acknowledged that the controls are complex. "Surgeons should think through what their fluidic and power requirements are for each stage of their phaco technique", he said. "These parameters are then pre-programmed into memory settings that are devoted to and selected for each stage of the procedure (eg, sculpt, chop, quadrant, epinucleus, etc.)."

Optimising fluidics performance allows reductions in phaco power and time,

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according to William J Fishkind, MD, FACS, of Fishkind & Bakewell Eye Care and Surgical Centre, Tucson, US, and the University of Utah, Salt Lake City, US. The improved phaco micro-pulse shaping also incorporated in Signature further reduces phaco power by maintaining what he calls "pre-occlusion" phaco mode. The brief "punch" at the beginning of each micro-pulse pushes the fragment away from the tip, preventing occlusion and maximising both the jackhammer and cavitation effects.

Altogether, these new technologies support smaller incisions, improved post-surgery corneal clarity, and preserve the integrity of the capsular bag and other intraocular structures. Dr Fishkind said. This not only means better outcomes for patients, it also facilitates the precise surgical approaches needed to successfully implant the multifocal and toric lenses – and meet the ever more stringent outcome expectations of refractive cataract patients.

devgan@ucla.edu
wfishkind@earthlink.net
doyan@earthlink.net