# The new phaco technology and its effect on phaco techniques

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## Introduction

The new phacoemulsification technology offers dramatic new options and expanded capabilities for cataract surgery, but demands of the surgeon an intimate understanding of the technology and the interplay of the machine parameters. This paper reviews the options now available to work with this technology.

## Alcon Legacy

In the Alcon Legacy, new tip, hub and handpiece designs combined with a new microprocessor-controlled, multifrequency, ultrasonic driver provide more efficient cutting at all power levels with lower turbulence and improved 'followability'. Extremely brunescent nuclei are grooved at 0-6 mmHg vacuum level and 16 ml per minute of flow, without contact at the nucleus by the phaco tip. There is no downward pressure on the nucleus and no forward movement of the nucleus even though the second handpiece is not being used for countertraction. The expanded cavitation wave breaks the nucleus before contact by the phaco tip.

New pump designs with non-compliant tubing and microprocessor control result in advanced fluidics with advantages of both the peristaltic and Venturi systems, providing enhanced chamber stability and faster rise times. Chamber stability is adequate to remove the cortical envelope following flipping of the epinucleus with the phaco handpiece, and there is complete stability of the posterior capsule without vaulting or threat of capsule rupture because of the fluidic system stability.

The programmable features of the Legacy system allow us to have a different program (see table of parameters) for each of three grades of nuclear hardness: soft, medium and firm. In addition, we have four memory settings, one for each of the four segments of the procedure. These are divided into sculpting, quadrant removal, trimming of the epinucleus, and flipping and removal of the epinucleus. Sculpting is done at 0-6 mmHg vacuum with a flow of 16 ml per minute. Quadrant removal then takes place with a vacuum between 80 and 120 mmHg, depending on nuclear density. Trimming of the epinucleus is done at 100 mmHg of vacuum. The vacuum then is reduced for flipping the epinucleus and removing the epinuclear

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shell from the eye, thus allowing new levels of safety, reproducibility and control. The most important feature in the Legacy system is its markedly enhanced cutting ability.

### AMO Prestige

The AMO Prestige features three outstanding characteristics: *1.* advanced computer technology; *2.* high performance fluidics; and *3.* multiple new programmable features. The holding power of the handpiece in quadrant removal is enormous, because this system works at vacuum levels previously considered dangerously high and unacceptable for working within the intraocular environment. Vacuums between 400 and 500 mmHg are routinely used for quadrant removal. This holding power allows great control in manipulating the quadrant with respect to its position, keeping it within the epinuclear shell and removing it without chatter. The microprocessor senses the formation, or clearance of occlusions at the tip, as well as any vacuum changes. As the vacuum builds, the computer reduces the pump speed to minimize pressure swings and post-occlusion vacuum surges that may cause chamber collapse or capsule vaulting.

By correct selection of parameters, the advantages of very high pressure with extremely stabile fluid dynamics are evident. Therefore, after flipping of the epinucleus, removing the residual cortex with the phaco tip utilizing the second handpiece without fear of vaulting of the posterior capsule and capsule rupture is possible.

Utilizing the Prestige, the surgical procedure once again is divided into four steps: sculpting or creating grooves, quadrant removal, trimming of the rim of the epinucleus, and finally flipping and removal of the epinucleus from the eye. The power is always on surgeon control and is linear, so it can be customized after reading the actual hardness of the nucleus. The aspiration flow rate is kept basically at 16 ml per minute, which is adequate for incision cooling. The sculpting of this system takes place at 0-4 mmHg vacuum. Quadrant removal, however, is done at very high vacuum levels, 400-500 mmHg, which of course is what allows for the exceptional holding power and control during removal of the nuclear quadrants.

Trimming and flipping of the epinucleus are done at much lower vacuum levels. The stability of the anterior chamber brought about by the advanced fluidics is a great safety feature. At the completion of the grooving or sculpting, pulse phacoemulsification is used. The most important feature of the Prestige system is the enhanced holding power, which may be most advantageous in the phaco-chop techniques.

### Storz Premiere with the MicroSeal handpiece

The new Storz MicroSeal handpiece performs comfortably through a 2.5-mm incision, constructed by a special keratome. This handpiece almost completely eliminates incisional outflow of fluid during the procedure. The handpiece consists of a central titanium needle surrounded by a Teflon cooling sleeve which is, in turn, surrounded by a soft silicone sleeve. The soft outer sleeve conforms to the changing configuration of the incision during the procedure and blocks incisional outflow, allowing stabile elevation of intraocular pressure and dramatic expansion and stability of the working space in the anterior segment of the eye.

Working space increases dramatically. There is very little flow from the incision

and very little movement of the iris or fluctuation of the chamber depth, which provides for greater safety and control and helps decrease trauma, because the total fluid volume through the eye is reduced to an average of about 50 ml. Because of the decreased incisional outflow, currents in the eye do not compete. Rather, since almost all of the outflow is through the phaco tip, there is much less turbulence in the anterior segment.

In this system the option of setting a flow rate is not arbitrary, since the flow rate is determined by the vacuum selected. Although we use a vacuum of 30 mmHg for sculpting and bring it up to 60 mmHg for other steps of the procedure, many surgeons utilize much higher vacuum levels with this Venturi system. Most nuclei can be removed with relatively low power settings and pulse mode can be relied upon once there are mobile segments of nucleus in the eye. The major advantages of this system include a marked expansion in the working space and increased followability, especially helpful in quadrant/segment removal.

### *Chiron Phacotron Gold Plus*

The Chiron machine comes with an 0.8-mm phaco tip, 20% smaller than the 1 mm-tip on most phaco machines. While in many cases down-sized phaco tips decrease efficiency and increase operating time, this is not the case with the Chiron tip, in part because of new ultrasound generator software. The smaller bore at the same vacuum levels increases followability, resulting in very stable fluid dynamics through a 2.6-mm clear corneal incision. In development for this machine is the phacotmesis handpiece, which features a rotating tip as well as ultrasound for cutting. This handpiece also incorporates a method to distinguish the nucleus from the capsule, which should help reduce the risk of capsule rupture.

### *Mentor Odyssey*

This low-priced, very capable system is the ultimate in transportability. It can be packed in a metal suitcase, weighing just 38 pounds when packed. A universal foot cable can be plugged into any electrical outlet, anywhere in the world. This is great for surgeons who travel locally and for those who demonstrate phaco techniques overseas. While not programmable, the parameters are easily changed. It cuts well and has superb fluid dynamics.

### *Ocusystem*

The Ocusystem, from Surgical Design Corporation, offers excellent cutting. Its Cobra tip handpiece offers the advantage of an expanded throat that breaks down aspirated material further with extra ultrasonic energy, much as a turbocharger on a jet airplane enhances thrust. The machine allows phaco through a 2.5-2.6-mm incision. The machine's fluid dynamics are excellent; the chamber remains stable throughout the procedure. The machine is programmable, and one can adjust the vacuum rise time independent of the flow rates. The vacuum level can rise slowly as occlusion is building and then quickly to its preset maximum once occlusion has been established – a very desirable feature.

*Table 1.* Fine phacoemulsification parameters

| | *Phaco settings* | | | *I/A control* | | |
|---|---|---|---|---|---|---|
| | *Sculpt* | *Chip/Quad* | *Trim* | *Flip* | *Cortical clean-up* | *Viscoat removal* |
| Alcon 10,000 Master (see note) | | | | | | |
| Power | 80 | 70 | 60 | 60 | surg vac control | |
| Aspiration | 16 | 20 | 20 | 20 | 30 | 30 |
| Vacuum | 1 | 100 | 80 | 80 | 400 | 400 |
| Mode | cont | pulse 10/sec | pulse 10/sec | pulse 10/sec | I/A mode | I/A mode |
| Alcon 20,000 Legacy with Kelman tip | | | | | | |
| | U/S mem 1 | pulse mem 1 | pulse mem 2 | pulse mem 3 | | |
| Power | 80 | 70 | 70 | 70 | surg vac control | |
| Aspiration | 16 | 16 | 16 | 16 | 16 | 30 |
| Vacuum | 0-6 | *80/100/120 | 100 | 50 | 500 | 500 |
| Mode | cont | pulse 8/sec | pulse 8/sec | pulse 8/sec | I/A mode | I/A mode |
| AMO Prestige (see note) | | | | | | |
| Power | 80 | 80 | 50 | 50 | surg vac control | |
| Aspiration | 16 | 16 | 16 | 16 | 30 | 30 |
| Vacuum | 0-6 | 400 | 80 | 80 | 500 | 500 |
| Mode | cont | pulse 10/sec | pulse 10/sec | pulse 10/sec | I/A mode | I/A mode |
| Storz Premiere with microseal handpiece | | | | | | |
| Power | 36% | 36% | 36% | 36% | surg vac control | |
| Vacuum | 30 | 60 | 60 | 60 | 400 | 400 |
| Mode | cont | pulse 8/sec | pulse 8/sec | pulse 8/sec | I/A mode | I/A mode |
| Mentor Odyssey (see note) | | | | | | |
| Power | *40% /55% | *40% /50% | *40% /55% | *40% /50% | surg vac control | |
| Aspiration | 16 | 16 | 16 | 16 | 18 | 22 |
| Vacuum | low 25 | *low 130/165 | low 130 | low 130 | high | high |
| Mode | cont | pulse 10/sec | pulse 10/sec | pulse 10/sec | I/A mode | I/A mode |

*Table. 1.* Cont'd

| | *Phaco settings* | | | | *I/A control* | |
|---|---|---|---|---|---|---|
| | *Sculpt* | *Chip/Quad* | *Trim* | *Flip* | *Cortical clean-up* | *Viscoat removal* |
| Surgical design Ocusystem II 'Art' | | | | | | |
| Power | 50% | 50% | 50% | 50% | surg vac control | |
| Aspiration | 6 | 6 | 6 | 6 | 8-12 | 8-12 |
| Vacuum | 0 | 120 | 90 | 90 | 175-500 | 175-500 |
| Mode | cont | pulse 6/sec | pulse 6/sec | pulse 6/sec | I/A mode | I/A mode |
| OMS Diplomax | Unoccl/Occl Thresh/Limit | Unoccl/Occl Thresh/Limit | Unoccl/Occl Thresh/Limit | Unoccl/Occl Thresh/Limit | | |
| Power | 100/100 | 80/80 | 60/60 | 60/60 | surg asp control | |
| Aspiration | 16/4 | 16/32 | 16/24 | 16/24 | 10 | 10 |
| Vacuum | 10/50 | 20/80 | 20/70 | 20/70 | 500 | 500 |
| Mode | auto | pulse 50% | pulse 50% | pulse 50% | I/A mode | I/A mode |
| Chiron Phacotron Gold Plus with ultratip system | | | | | | |
| Power | 50% | 50% | 50% | 50% | surg vac control | |
| Aspiration | 16 | 16 | 16 | 16 | 30 | 30 |
| Vacuum | 0 | 100 | 80 | 50 | 500 | 500 |
| Mode | linear | pulse 10/sec | pulse 10/sec | pulse 10/sec | I/A mode | I/A mode |

Note: 30° tip is used for 1-2+ nuclei; 45° tip is used for 3-4+ nuclei. *Nucleus 1-2+/3+/4+. **Nucleus 1-3+/4+

*OMS Diplomax*

Not yet available in the United States, the cutting-edge OMS Diplomax system cuts superbly, and its burst-mode phaco gives the surgeon the option of creating single, short bursts of ultrasound. One can press on the foot control and lollipop the nucleus with predictable blasts. It also has an auto-pulse phaco, which in low powers automatically runs into pulse mode. At higher powers, it switches to continuous mode phaco. The machine can be programmed so that when the tip is occluded, the ultrasound changes from continuous to pulse, auto-pulse or burst. It has a programmable vacuum rise rate, allowing a variety of options and two separate infusion pinch valves. This feature gives you the choice of having one or two bottles hung at different levels for slow or fast irrigation and aspiration. A phaco foot pedal allows switching of the memory settings without the need to tell the surgical assistant, and a gravity-fed reflux system prevents phaco material from reentering the eye.