# Phaco Machine Settings

BY WILLIAM J. FISHKIND, MD; R. BRUCE WALLACE III, MD; BONNIE AN HENDERSON, MD; D. MICHAEL COLVARD, MD; UDAY DEVGAN, MD; DONALD N. SERAFANO, MD; Y. RALPH CHU, MD; ELIZABETH A. DAVIS, MD; AND JAMES P. GILLS, MD

## WILLIAM J. FISHKIND, MD

During the last few years, manufacturers have introduced phaco machines that are strikingly superior to and more refined than previous units. Even those that have been in service for a number of years are eligible for several upgrades. I asked several surgeons which machine and phaco settings they use and what their phaco settings are.

I myself presently use the Sovereign cataract extraction system (Advanced Medical Optics, Inc., Santa Ana, CA) and a 19-gauge 0º phaco tip. My preferred technique is quick chop. I have four settings programmed into the machine (Table 1). I use "phaco 1" solely for the hardest cataracts and only to embed the tip and chop. Once I have completed numerous chops, I switch to "phaco 2" to mobilize and remove the fragments. I generally rely on "phaco 3" to remove softer nuclear/cortical material and epinucleus. Rarely, I employ "phaco 4" for a soft nucleus. All of the settings are designed to enhance partial occlusion phacoemulsification and to minimize surge.

## R. BRUCE WALLACE III, MD

I favor the new Stellaris Vision Enhancement System (Bausch & Lomb, Rochester, NY). Its enhanced fluidics have improved surgical safety. Although the flow-based option performs well, I prefer to use the vacuum system. I have found it to be amazingly responsive, which gives me greater confidence in cases of small pupils, shallow anterior chambers, and dense nuclei. Because the Stellaris anticipates changes in pressure in the anterior chamber, I am able to use higher vacuum levels than on earlier phaco machines. My program includes three settings (Table 2). The dual linear foot pedal allows me to use mostly phacoaspiration on the downstroke of the pedal and more phaco power, when needed, through my foot's movement outward. Using this phaco system, I am able to perform coaxial phacoemulsification through a microincision of 1.8 mm.

## BONNIE AN HENDERSON, MD

I primarily use the Infiniti Vision System with the Ozil Torsional handpiece (Alcon Laboratories, Inc., Fort Worth, TX). I prefer the 0.9-mm 45º miniflare ABS tip when I employ a microcoaxial approach, because I feel it delivers the best irrigation flow and provides increased protection against surge. I find that this combination allows me to perform safe, effective phacoemulsification for all types of

**TABLE 1. DR. FISHKIND'S SETTINGS**

| | Aspiration Rate, mL/min | Vacuum, mm Hg | Power | Whitestar Pulse Setting |
|---|---|---|---|---|
| Phaco 1 hard chop | | | | |
| Unoccluded | 26 linear | 350 panel | 40% | F/b |
| Occluded | 26 linear | 220 threshold | 40% | D/I 31%, CD 43%, CB 60%, DB 67% |
| Phaco 2 soft chop | | | | |
| Unoccluded | 24 panel | 275 linear | 25% | CL 20%, CF 33%, CD 43%, DB 67% |
| Occluded | 26 | 220 | 25% | CL 20%, CF 33%, CD 43%, DB 67% |
| Phaco 3 epinuclear | | | | |
| Unoccluded | 26 panel | 280 linear | 15% | CL 20%, CF 33%, CD 43%, DB 67% |
| Occluded | 26 panel | 200 | 15% | CF 4 long pulses per second |
| Phaco 4 slow | | | | |
| Unoccluded | 24 panel | 315 linear | 10% | C/N |
| Occluded | 24 | 215 | 10% | C/N |

*Note: with the Sovereign cataract extraction system.*

## Dr. HENDERSON'S SETTINGS

Dr. Henderson favors the Infiniti Vision System with the Ozil Torsional handpiece (Alcon Laboratories, Inc., Fort Worth, TX).

**Soft lenses**

*Sculpting*

- Ozil amplitude—85% (all torsional, no longitudinal), linear pedal control
- Vacuum—90 mm Hg, linear pedal control
- Aspiration—24 mL/min, fixed pedal control
- Bottle height—95 cm

*Chop/quadrant removal*

- Ozil amplitude—80% (all torsional), linear pedal control
- Vacuum—400 mm Hg, fixed pedal control
- Aspiration—35 mL/min, fixed pedal control
- Bottle height—105 cm

**Medium lenses**

*Sculpting*

- Ozil amplitude—85% (all torsional), linear pedal control
- Vacuum—100 mm Hg, linear pedal control
- Aspiration—24 mL/min, fixed pedal control
- Bottle height—95 cm

*Chop/quadrant removal*

- Ozil amplitude—80% (all torsional), linear pedal control
- Vacuum—400 mm Hg, fixed pedal control
- Aspiration—35 mL/min, fixed pedal control
- Bottle height—105 cm

**Dense lenses**

*Sculpting*

- Ultrasound longitudinal power, 35% linear, 10% on time, 22 pulses per second, combined with Ozil amplitude, linear 100%, 90% Ozil on time
- Vacuum—90 mm Hg, linear pedal control
- Aspiration—24 mL/min, fixed pedal control
- Bottle height—95 cm

*Chop/quadrant removal*

- Ultrasound longitudinal power, 40% linear, 5% on time, 10 pulses per second, combined with Ozil amplitude, linear 100%, 95% Ozil on time
- Vacuum—400 mm Hg, fixed pedal control
- Aspiration—35 mL/min, fixed pedal control
- Bottle height—105 cm

lenses. It is possible to remove cataracts of all densities with a single phaco setting due to technological improvements in the forms of (1) aspiration bypass systems that prevent the buildup of heat, (2) stiffer tubing that maintains the chamber's stability, and (3) linear and fixed

**TABLE 2. DR. WALLACE'S SETTINGS**

| Phase | Submode | Power | Pulses per Second | Duty Cycle | Bottle Height, cm | Vacuum, mm Hg |
|---|---|---|---|---|---|---|
| Sculpting | 1 | 0 to 45% | 250 | 50% | 85 | 0 to 50 |
| | 2 | 0 to 60% | 250 | 50% | 85 | 0 to 60 |
| | 3 | 0 to 60% continuous | | | 85 | 0 to 50 |
| Segment removal | 1 | 10% to 28% dual linear | 50 | 40% | 108 | 0 to 390 |
| | 2 | 10% to 40% dual linear | 50 | 40% | 108 | 0 to 390 |
| | 3 | 0 to 12% dual linear | 50 | 40% | 108 | 0 to 390 |
| Epinuclear | 1 | 0 to15% continuous | | | 100 | 0 to 325 |

*Note: with the Stellaris Vision Enhancement System. Submode 1 for standard nuclei, 2 for dense nuclei, and 3 for soft nuclei.*

**TABLE 3. DR. COLVARD'S SETTINGS**

| Setting | Aspiration Rate (mL/min) | Vacuum Limit (mm Hg) | Power |
|---|---|---|---|
| Phaco 1 (sculpting) | 22 | 60 | 60% |
| Phaco 2 (segment removal) | 35 | 350 | 60% |
| Phaco 3 (epinucleus) | 35 | 180 | 20% |

*Note: with the Sovereign Compact.*

pedal settings that enhance surgeon control. Nevertheless, I vary the parameters for lenses of different grades (see *Dr. Henderson's Settings*). I mainly use the stop-and-chop technique.

## D. MICHAEL COLVARD, MD

Over the years, I think I have tried virtually every phaco technique I have ever seen or read about, and I have taught myself the same lesson over and over again. The best way to ensure that the cornea will be crystal clear on the day after surgery is to stay away from it. Techniques that tend to bring the nucleus into the anterior chamber are faster but not as gentle to the cornea as those that encourage the surgeon to stay below the iris plane.

Except for very soft lenses, which I can subluxate above the iris by means of hydrodissection and then simply aspirate, I perform a central groove and then a series of vertical and/or horizontal chops, as described originally by Paul Koch, MD.[1] The groove, which is cracked before chopping, allows me to chop at lower vacuum levels. Much more importantly, the groove provides an empty space below the iris plane where I can safely perform phacoemulsification. Denser nuclei need to be chopped into smaller segments, but the basic phaco parameters I use are the same for all cases. My surgery center has several Sovereign Compact units (Advanced Medical Optics, Inc.), and I am extremely happy with this system. I use Whitestar pulse settings (Advanced Medical Optics, Inc.), and, regardless of the density of the nucleus, I never seem to need more than 60% of the machine's phaco power. Table 3 shares my parameters.

## UDAY DEVGAN MD

I use several different phaco machines at a private surgical center as well as at the Olive View UCLA Medical Center to teach ophthalmology residents. The newer phaco platforms are far better than their predecessors. If you are using a machine that is a few years old, you owe it to yourself to test drive the newer models.

I prefer large-bore phaco needles for dense cataracts, because they allow for more efficient phaco aspiration of the nuclear material. On the new Stellaris Vision Enhancement System, I prefer the MicroFlow Plus needle in combination with the high-vacuum tubing, and I like using a phaco pulse mode. The concept of increasing the phaco power level for dense cataracts is well known. In addition, I increase the duty cycle of the pulse mode as the nuclear density increases, with as low as 20% for a soft lens and as high as 80% for a brunescent one. I keep the pulse rate high (between 80 and 120 pulses per second),

**TABLE 4. DR. DEVGAN'S SETTINGS**

| | Phaco Parameters | | | Fluidic Parameters | | |
|---|---|---|---|---|---|---|
| Nucleus' Grade | Power Level | Pulse Rate (pulses per second) | Duty Cycle | Bottle Height, cm | Vacuum, mm Hg | Aspiration, mL/min |
| I | 5% to 10% | 80 to 120 | 20% | 100 | 300 to 500 | 35 to 50 |
| II | 10% to 20% | 80 to 120 | 40% | 100 | 300 to 500 | 35 to 50 |
| III | 20% to 40% | 80 to 120 | 60% | 100 | 300 to 500 | 35 to 50 |
| IV | 40% to 60% | 80 to 120 | 80% | 100 | 300 to 500 | 35 to 50 |

*Note: with the Stellaris Vision Enhancement System using a MicroFlow Plus Needle, peristaltic pump, and high-vacuum tubing.*

**TABLE 5. DR. SERAFANO'S SETTINGS**

| Phase | Amplitude | Vacuum | Aspiration Flow Rate |
|---|---|---|---|
| Prephacoemulsification | 20% linear | 180 mm Hg fixed | 30 mL/min linear |
| Sculpting | 100% linear | 90 mm Hg linear | 22 mL/min fixed |
| Quadrant | 100% linear | 400 mm Hg fixed | 38 mL/min fixed |
| Epinuclear | 20% linear | 320 mm Hg linear | 32 mL/min linear |

*Note: for a 2.75-mm incision with Ozil continuous torsional ultrasound on the Infiniti Vision System.*

| Phase | Amplitude | Vacuum | Aspiration Flow Rate |
|---|---|---|---|
| Prephacoemulsification | 20% linear | 180 mm Hg fixed | 30 mL/min fixed |
| Sculpting | 100% linear | 90 mm Hg linear | 22 mL/min fixed |
| Quadrant | 100% linear | 350 mm Hg fixed | 38 mL/min fixed |
| Epinuclear | 20% linear | 320 mm Hg linear | 28 mL/min linear |

*Note: for an incision smaller than 2.40 mm with the Infiniti Vision System.*

which I feel provides better followability and less risk of built-up heat at the phaco tip (Table 4).

For dense cataracts, my main advice is carefully to modulate the phaco power, to recoat the corneal endothelium periodically with viscoelastic, and to take your time. If you are using a phaco machine from the previous generation such as the Millennium microsurgical system (Bausch & Lomb), you can still implement some of these techniques to improve surgery on dense cataracts. With the Millennium, you can program a variable duty cycle and a wide range of power modulation parameters, although not quite up to the range available on the Stellaris. Older phaco machines may have a tendency for more fluidic imbalance and surge, so it is advisable to use more conservative settings, including lower flow and vacuum and perhaps a higher bottle.

## DONALD N. SERAFANO, MD

I use the Infiniti Vision System with the Ozil Torsional handpiece for cataracts of all grades. Ozil with a 45° mini-flared Kelman tip can emulsify a cataract of any grade with only a setting of basic continuous torsional ultrasound and moderate fluidic settings. Because torsional ultrasound almost eliminates repulsion and increases thermal safety, I do not change my phaco parameters based on the density of the nucleus.

Instead, I base my phaco parameters on the steps of the procedure (Table 5). For instance, just before phacoemulsification, I establish flow by using moderate fluidic settings with a very low torsional amplitude. The sculpting phase is nonocclusive with continuous linear torsional ultrasound and moderate fluidics. In the quadrant phase, I only adjust to a higher vacuum setting with a

**TABLE 6. DR. CHU'S SETTINGS**

| Setting | Aspiration Rate, mL/min | Vacuum | Power, % | Whitestar Pulse Setting | Pump Ramp, % | Bottle Height, cm |
|---|---|---|---|---|---|---|
| Phaco 1<br>Phaco Flip<br>*Unoccluded* | 36 | 250 L | 50 | 16/24, 14/16,12/11 10/8 Variable Whitestar 1 | 70, 70 | 85 |
| *Pulse Shaping* | 1% to 12% | 0 to 70% | | | | |
| *CASE Vacuum* | N/A | | | | | |
| Phaco 2<br>Grooving | 20 | 40 L | 65 | 7/3, 70% duty | 70, 70 | 55 |
| *Pulse Shaping* | 1 to 12% | 0 to 70% | | | | |
| *CASE Vacuum* | N/A | | | | | |
| Phaco 3<br>Phaco Flip<br>With CASE<br>*Unoccluded* | 36 | 325 L | 50 | 16/24, 14/16,12/11 10/8 Variable Whitestar 1 | 70, 70 | 85 |
| *Pulse Shaping* | 1% to 12% | 0 to 70% | | | | |
| *CASE Vacuum (used)* | | 250 CASE vacuum | 290 mm up | 75 mm down | time 500 milliseconds | |
| Phaco 4<br>Tamsulosin Low Flow<br>*Unoccluded* | 24 | 200 L | 50 | 16/24, 14/16,12/11 10/8 Variable Whitestar 1 | 70, 70 | 60 |
| *Occluded* | | | | | | |
| *CASE Vacuum* | N/A | | | | | |

*Note: with the Whitestar Signature System with Fusion Fluidics. CASE = Advanced Chamber Stabilization Environment (CASE) technology.*

slight modification in minimum ultrasound. During this phase, I use continuous Ozil torsional ultrasound but adjust the linear amplitude to start at 20%.

I do, however, slightly change my parameters based on the size of the incision. For instance, I have certain settings for my standard 2.75-mm phaco incision. I reduce vacuum somewhat for microcoaxial phacoemulsification, in which the incisions are 2.40 mm or smaller, to compensate for the decreased flow. I use the Intrepid Fluid Management System (Alcon Laboratories, Inc.), which reduces my need to adjust my settings or the bottle's height when adopting microcoaxial phacoemulsification.

## Y. RALPH CHU, MD

I currently prefer the Whitestar Signature System with Fusion Fluidics (Advanced Medical Optics, Inc.). I use the phaco flip setting for the majority of cataracts. I generally use a 19-gauge phaco tip, but I employ a Dewey Radius phaco tip (MicroSurgical Technology, Redmond, WA) for soft nuclei. For dense nuclei, I prefer a phaco tip with a chiseled edge such as the Chu Chisel (Mastel Precision, Inc., Sioux City, SD). Table 6 shows my settings, including those for when a grooving method is necessary. For extremely hard nuclei, I sometimes incorporate a second mode of phaco flip, which includes

**TABLE 7. DR. GILLS' SETTINGS**

| Phase | Pulses per Second | Torsional Amplitude | Percentage or Burst on Time | Aspiration Flow Rate | Vacuum Limit |
|---|---|---|---|---|---|
| Sculpting | 0 | 35% linear | 0 | 23 mL/min fixed | 350 mm Hg linear |
| Quadrant | 0 | 85% linear | 0 | 20 to 40 mL/min linear | 370 mm Hg fixed |
| Epinuclear | 10 | 75% linear | 75% on time | 30 mL/min linear | 300 mm Hg linear |

*Note: with the Infiniti Vision System, Ozil Torsional handpiece, and a bottle height of 105 cm.*

Advanced Chamber Stabilization Environment technology (Advanced Medical Optics, Inc.). This feature is particularly helpful in situations requiring high vacuum. My fourth phaco setting is low flow, which I find extremely useful in patients who are taking tamsulosin or in those with small pupils. This setting effectively maintains the chamber's stability and thus minimizes the turbulence in the eye that could disrupt the iris.

## ELIZABETH A. DAVIS, MD

Phaco energy—although useful for emulsifying nuclear material—can create inflammation, cause corneal edema and the loss of endothelial cells, and damage other intraocular structures. Minimizing phaco energy is therefore important in cataract surgery. In addition to the use of power modulations to reduce total energy, one can also employ high vacuum so that aspiration, rather than ultrasound, evacuates lenticular particles. High vacuum levels can only be achieved safely when fluidics are optimized and postocclusion surge is avoided.

I prefer a high-vacuum supracapsular approach. Working in the iris plane minimizes capsular complications and, in eyes with small pupils or floppy irides, enhances visualization. By combining the Stellaris Vision Enhancement System with high-resistance outflow tubing such as Bausch & Lomb's Stable Chamber tubing or Cruise Control from STAAR Surgical Company (Monrovia, CA), I am able to use aspiration alone, without phaco energy, in at least 80% of my patients (see *Dr. Davis' Settings*). I also enjoy performing sub-2-mm coaxial surgery on this phaco system and have used both the flow module (which allows me to switch between flow and vacuum control even within a single case) and the vacuum module with success.

### DR. DAVIS' SETTINGS

Dr. Davis favors the Stellaris Vision Enhancement System from Bausch & Lomb (Rochester, NY).

**Vacuum Mode Using the Advanced Flow System**

- 300 to 400 mm Hg dual linear vacuum
- 1% to 30% ultrasound power, 50 pulses per second, 60% duty cycle
- Bottle height of 125 cm

- I/A
- 0 to 550 mm Hg
- Bottle height of 125 cm

**Flow Mode Using the Advanced Flow System**

- 40 mL/min flow
- 350 to 450 mm Hg vacuum
- 1% to 30% ultrasound power, 50 pulses per second, 60% duty cycle
- Bottle height of 125 cm

- I/A (vacuum mode)
- 0 to 550 mm Hg
- Bottle height of 125 cm

*Above setting combined with Stabile Chamber tubing (Bausch & Lomb) or Cruise Control tubing (STAAR Surgical Company, Monrovia, CA).*

## JAMES P. GILLS, MD

I use the Infiniti Vision System with the Ozil Torsional handpiece, a 45° Kelman mini-flare tip, and a phaco chop/divide-and-conquer surgical technique.

For soft lenses, I use the lowest settings (Table 7). I typically start with a horizontal chop and will frequently cut off or use modulated torsional power, because so much of the soft material is vacuumed with moderate or little use of ultrasound.

To address lenses of medium density, I switch to a divide-and-conquer approach and, providing the visualization is good, use a combination of vertical and horizontal chop. In the event of poor visualization, I attempt a quick chop, sculpt out the central part of the nucleus, divide it, and fragment the lens into six or eight pieces prior to its removal. I frequently use this approach in the eyes of patients taking tamsulosin.

For hard lenses, I employ slightly higher flow and vacuum settings; I sometimes use 100% continuous torsional

ultrasound to perform a vertical chop with a sharply pointed manipulator. When creating these pie-shaped divisions, I take extra care not to chop the anterior capsule during phacoemulsification. I divide the lens into eight, 12, or 16 pieces using a combination of vertical and horizontal chop. ■

*Section Editor William J. Fishkind, MD, is Co-Director of Fishkind and Bakewell Eye Care and Surgery Center in Tucson, Arizona, and Clinical Professor of Ophthalmology at the University of Utah in Salt Lake City. He is a consultant to Advanced Medical Optics, Inc. Dr. Fishkind may be reached at (520) 293-6740; wfishkind@earthlink.net.*

*Y. Ralph Chu, MD, is Founder and Medical Director of the Chu Vision Institute in Edina, Minnesota. Dr. Chu is also Adjunct Associate Professor of Ophthalmology at the University of Minnesota in Minneapolis and Clinical Professor of Ophthalmology at the John Moran Eye Institute, University of Utah, Salt Lake City. He is a consultant to Advanced Medical Optics, Inc. Dr. Chu may be reached at (952) 835-0965; yrchu@chuvision.com.*

*D. Michael Colvard, MD, is Associate Clinical Professor at the Keck School of Medicine, University of Southern California School of Medicine in Los Angeles, and he is Director of the Colvard Eye Center in Encino, California. He is a consultant to Advanced Medical Optics, Inc., and Bausch & Lomb. Dr. Colvard may be reached at (818) 906-2929; eyecolvard@earthlink.net.*

*Elizabeth A. Davis, MD, is Adjunct Clinical Assistant Professor at the University of Minnesota in Minneapolis and Director of the Minnesota Eye Laser and Surgery Center, Minnesota Eye Consultants, Bloomington. She is a consultant to Bausch & Lomb and STAAR Surgical Company. Dr. Davis may be reached at (952)-567-6068; eadavis@mneye.com.*

*Uday Devgan, MD, is a partner at the Maloney Vision Institute in Los Angeles. Dr. Devgan is Chief of Ophthalmology at Olive View UCLA Medical Center and Associate Clinical Professor at the UCLA School of Medicine. He is a consultant to Bausch & Lomb. Dr. Devgan may be reached at (310) 208-3937; devgan@ucla.edu.*

*James P. Gills, MD, is Founder and Director of St. Luke's Cataract & Laser Institute in Tarpon Springs, Florida. He is on the speakers' bureau for and is a stockholder in Alcon Laboratories, Inc. Dr. Gills may be reached at (727) 938-2020; jgills@stlukeseye.com.*

*Bonnie An Henderson, MD, is Assistant Clinical Professor of Ophthalmology at Harvard Medical School in Boston and is a partner in Ophthalmic Consultants of Boston. She is on the speakers' bureau for and has received grant support from Alcon Laboratories, Inc. Dr. Henderson may be reached at bahenderson@eyeboston.com.*

*Donald N. Serafano, MD, is in private practice in Los Alamitos, California, and is Clinical Associate Professor of Ophthalmology at the University of Southern California in Los Angeles. He is a consultant to Alcon Laboratories, Inc. Dr. Serafano may be reached at (562) 598-3160; serafano@gte.net.*

*R. Bruce Wallace III, MD, is Medical Director of Wallace Eye Surgery in Alexandria, Louisiana. Dr. Wallace is also Clinical Professor of Ophthalmology at the LSU School of Medicine and Assistant Clinical Professor of Ophthalmology at the Tulane School of Medicine, both in New Orleans. He is a consultant to Advanced Medical Optics, Inc., and Bausch & Lomb. Dr. Wallace may be reached at (318) 448-4488; rbw123@aol.com.*

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