

# Wound Temperature and the Sovereign Whitestar Technology

A review of bimanual settings and wound temperature studies.

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Over the past several years, ophthalmologists have been deeply interested in developing less invasive surgical techniques to make cataract surgery safer and speed patients' postoperative rehabilitation. Perhaps the most important recent innovation in small-incision ocular surgery is the development of bimanual microincisional phacoemulsification (also commonly known as *bimanual microphacoemulsification*). The advantages of small-incision surgery are significant and will continue to improve with new developments in IOL design. The advantage of bimanual microincisional phacoemulsification is that it is more efficient than traditional phacoemulsification and therefore reduces endothelial cell loss and creates less intraocular inflammation. It will also

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provide more rapid visual rehabilitation with the development of small-incision IOLs. Currently, new lenses available in Europe are designed to fit through 1.2- to 1.4-mm incisions, and injectable implants are now undergoing FDA clinical investigation in the US. Once the FDA approves a sub-2-mm IOL that provides good long-term results, the adoption of bimanual microincisional phacoemulsification will increase exponentially.

## BENEFITS

One major benefit of performing bimanual microincisional phacoemulsification with the Sovereign Whitestar Technology (Advanced Medical Optics, Inc., Santa Ana, CA) is the enhanced intraoperative control and stability the system provides when operating in an almost completely closed anterior chamber. Whitestar Technology essentially eliminates iris prolapse as well as reduces fluid flow through the eye, a fact that benefits patients with decreased endothelial cell counts.

One of the improvements is Whitestar's micropulse technology with high-frequency pulsing and microburst modes, which cool the phaco tip and allows surgeons to perform bimanual microincisional phacoemulsification without an irrigation sleeve. The coolness of the phaco tip compared with earlier phaco technologies increases the



Figure 1. The thermocouple thermometer wire measures wound temperature during bimanual phacoemulsification with Whitestar Technology.



Figure 2. Linear-control duty cycle and power control with the Whitestar 6.0 software are shown.

safety level of the procedure. Heat is a byproduct of work, and the most effective way to minimize heat production in phacoemulsification is to maximize the efficiency of the work performed, a concept at the heart of micropulse technology. By allowing the rapid duty cycles to pulse on and off at extremely rapid rates, micropulse technology delivers significant heat to the surrounding tissue. In practice, the faster the duty cycle of the phaco tip revolves, the more efficiently the tip disperses low-level heat into the surrounding tissue. Although micropulse phacoemulsification is also termed *cold phacoemulsification*, it is not cold. Nonetheless, the colder the phacoemulsification, the safer the microincisional surgery. This is the key concept in performing bimanual phacoemulsification—ensuring that it is safe.

## EXPERIENCE

Dr. Donnenfeld and his colleagues began using the Whitestar Technology by employing a 6-millisecond–on, 12-millisecond–off duty cycle, which allowed them to use 33% less energy than with other conventional phaco devices that pulse on and off with equal cycles. They have shown<sup>1</sup> that, by using this micropulse technology with longer off-duty cycles, the wound-temperature gradients in patients undergoing bimanual phacoemulsification with Whitestar Technology rise to 34.1° C, far below the temperature needed to shrink collagen (60° C).<sup>2</sup> Further investigation of the Whitestar Technology is required, however, because the potential number of variations in its on/off energy cycles is almost endless, and some variations may offer specific clinical advantages.

Ten patients underwent phacoemulsification using mi-

cropulse technology without an irrigating sleeve through a 1.2-mm clear corneal incision. Before beginning the procedure, Dr. Donnenfeld and his colleagues used a 30-gauge needle to create a superior tract through the midcorneal stroma at the limbus. They also placed a Type-TP (Physitemp Instruments, Inc., Clifton, NJ), copper-Constantan, thermocouple thermometer wire into the clear cornea and attached it to a thermal probe (Figure 1). The thermal probe displayed temperatures digitally, using measurements of very small DC electrical voltages. The Type-TP thermocouple wire was Teflon-coated and accurate to 0.1° C at a range of 0 to 50.0° C. They also attached the 30-gauge thermocouple wire to an autocorrecting BAC-12 temperature monitoring system.

Dr. Donnenfeld and his colleagues continually displayed standardized temperature records on the BAC-12 system and recorded them every 30 seconds. They took the maximum temperature at every stage of the phaco procedure. Phaco 1 settings consisted of a 50% power setting, a 50% micropulse setting, 20 mL/min of aspiration, and 40 mm Hg of vacuum. Phaco 2 settings consisted of the same power, micropulse, and aspiration settings, but a vacuum setting of 250 mm Hg. They recently began using the 6.0 software (Figure 2), which provides linear control of phaco energy and the Whitestar Technology duty cycle. They start with a duty cycle of four on cycles and 20 off cycles (16% duty cycle) and increase the energy and duty cycle to six on cycles and 12 off cycles (33% duty cycle) with linear foot control. Eyebank studies have further documented the safety and minimal wound-temperature gradients of the Whitestar Technology.<sup>3,4</sup>

The decreased energy expenditure of the Whitestar technology, which results from rapid on/off cycles, further reduces the dispersive forces that drive nuclear fragments away from the phaco tip. Although ultrasound always pushes nuclear fragments away in other technologies, the Whitestar Technology's ultrasound pulses are so short that the aspiration forces predominate. The Whitestar Technology's reduced hydrodispersive flow and ultrasonic energy produces less turbulence in the anterior chamber, an improvement that increases followability and control in removing nuclear fragments. As a result, the surgeon can perform phacoemulsification safely, without temperature-related damage.

### FLUIDICS

The ophthalmologist must adapt to Whitestar bimanual microincisional phacoemulsification. Primarily, he must familiarize himself with the system's fluidics. Dr. Donnenfeld and his colleagues use an irrigating chopper or irrigating cyclo-dialysis spatula. These devices do not allow as much flow as conventional irrigation with traditional phacoemulsification. To prevent oarlocking, they use a trapezoidal 1.2- to 1.4-mm diamond blade and a 21-gauge phaco needle. They raise the irrigation bottle with an extender to increase the gravitational feed of irrigation into the eye. Dr. Donnenfeld and his colleagues use a large-bore irrigation cannula, and they decrease the vacuum to a maximum height of 250 mm Hg when they start in order to make certain that they maintain a stable anterior chamber. Then, they adjust the vacuum power to fit their surgical technique. Dr. Donnenfeld currently presets his vacuum level to 300 mm Hg. He feels comfortable with this level of vacuum, although he has obtained stable anterior chambers with vacuum levels as high as 400 mm Hg.

### IN CLOSING

Dr. Donnenfeld and Dr. Olson consider Whitestar Technology bimanual microincisional phacoemulsification to be a significant advance in cataract extraction. The ability to insert an IOL through a 1.2-mm incision will further drive IOL technology and make bimanual microincisional phacoemulsification the standard for cataract extraction in the near future. The learning curve for this technique is rapid, the benefits to the patient are significant, and the transition is easy. ■

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