A Bent-Tip Phaco Needle Is More Efficient

Both bent- and straight-tip needles can effectively be used with bidirectional phaco; however, video analysis suggests that the bent-tip design may increase cavitational energy dispersion.

BY DONALD R. NIXON, MD, FRCSC, DIPABO

Surgeons' adoption of transversal phacoemulsification has been slower than some might have expected. Although it is a significant technological advance forward, some have not been comfortable with the technology because, when it was first developed, it required the use of a bent-tip phaco needle. Surgeons who favored a straight tip chose to bypass the new technology.

Alcon Laboratories, Inc., has recently developed new software, Intelligent Phaco (IP), which generates longitudinal phacoemulsification bursts upon occlusion, making the system bidirectional, but it has not yet been formally evaluated with a straight needle. Another bidirectional phaco system, the WhiteStar Signature System with Ellips FX (Abbott Medical Optics Inc.) employs a blend of longitudinal and transversal energy and can accommodate either a bent or straight tip.

STUDY TO ASSESS TIP DESIGN

I conducted a study to assess the effect of the tip design (bent vs straight) on phacoemulsification performance parameters during microincisional cataract surgery. I used the WhiteStar with the Ellips FX and evaluated 156 patients undergoing uncomplicated cataract surgery. My phaco technique (horizontal chop), bottle height, vacuum, and pump ramp settings were consistent for all cases. My power settings utilizing a non-zero start mode were 10% to 25% in the straight-tip group and 5% to 15% in the bent-tip group. All phaco tips were 21 gauge, and the surgery was carried out through a 2.2-mm incision. The outcome measures were total ultrasound FX energy (power), the amount of balanced salt solution used for irrigation, and total phaco time (time).

I graded the cataracts using the Oculus Pentacam Nucleus Grading System PNS (Oculus Optikgeräte GmbH), which objectively and reproducibly grades nuclear density. The table shows the distribution of cataract grades treated with the two tips. In addition to the in vivo study, I carried out an in vitro evaluation using high-speed video to compare and contrast energy dispersion with the two tips.

TABLE. NUMBER OF CASES BY DENSITY OF NUCLEUS IN EACH GROUP

	Cataract Density				
	1	**2**	**3**	**4**	**5**
Straight tip	15	31	31	19	5
Bent tip	6	18	18	10	3
Total	21	49	49	29	8

STUDY RESULTS

The results showed that the bent tip was more efficient than the straight tip across the board (Figure). My statistical evaluation of the bent tip compared with the straight tip displayed significantly ($P < .05$) less power, less balanced salt solution, and less phacoemulsification time across all grades of cataract with the bent tip. It was particularly noticeable in the hardest (grade 5) cataracts where the absolute differences were the greatest (although there were relatively few of these cases). It had been my clinical impression that the bent-tip phaco needle was more efficient, but this was the first time an objective evaluation had been performed using the WhiteStar system with FX.

Although the bent tip was more efficient, the results also demonstrate that, at least with bidirectional phacoemulsification, the surgeon can effectively remove a cataract with a straight needle. High-

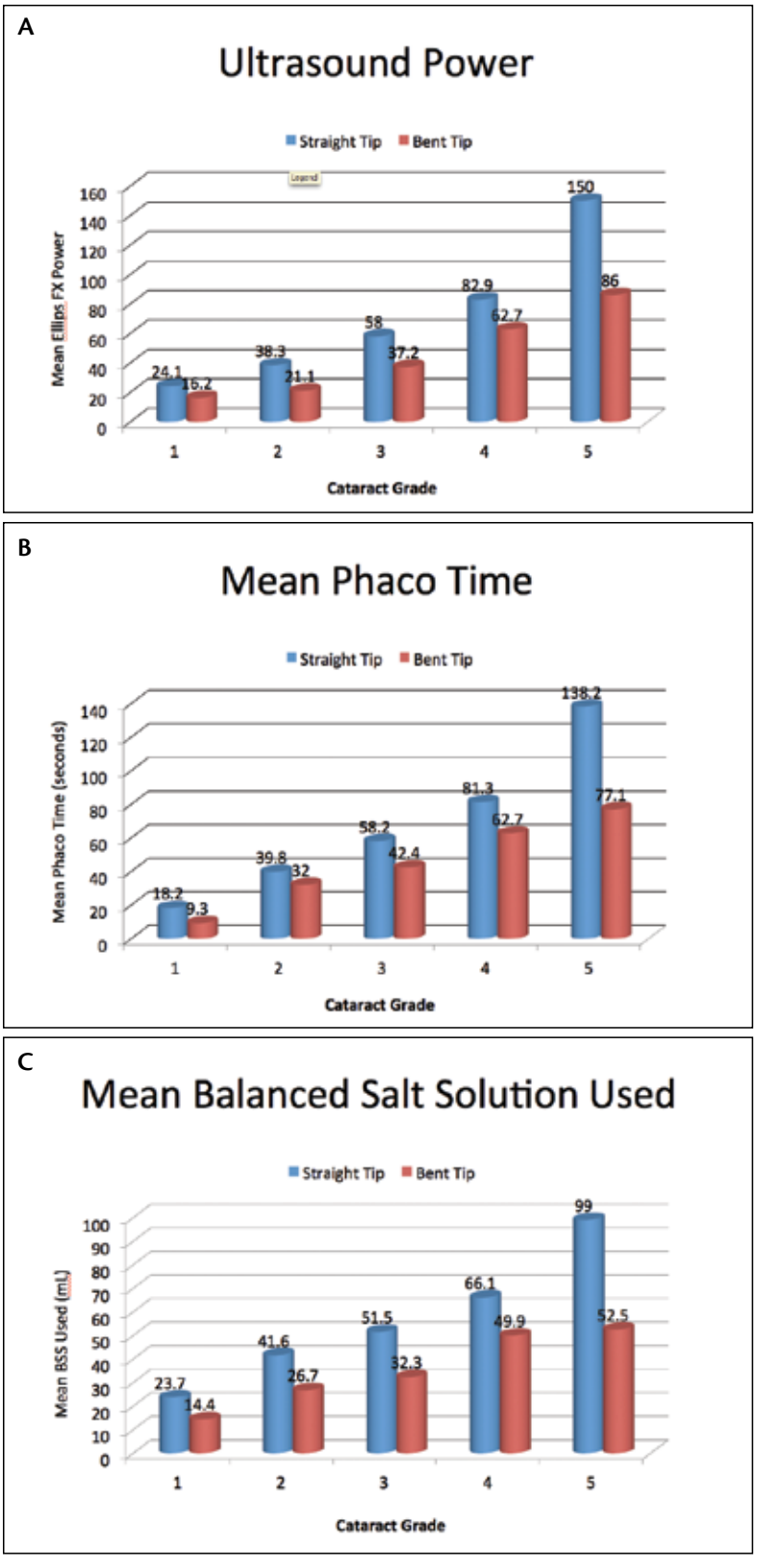

Figure. The bent tip was more efficient than the straight tip across the board.

speed video provides some insight into why this is so.

It is understood that phaco energy generated at the needle tip is a combination of both mechanical (direct contact) energy as well as cavitational acoustic energy. Dr. Mark E. Schafer and others have furthered our understanding of transient cavitation, which leads to the violent collapse of microbubbles that exist in the fluid in which the cavitation is created. It is that explosive collapse of bubbles that emulsifies the dense nucleus in cataractous lenses with acoustic, noncontact shock waves. The cavitational effect is influenced by the shape and size of the needle as well as the amount and duration of the energy pulse.

IN VITRO ANALYSIS

I performed the in vitro video analysis using identical handpieces, power settings, and the same 21-gauge straight and 21-gauge bent tip needles used in the clinical study. I used two paired videos running at 1 million frames per second to observe and compare the straight and bent needles' movement at power settings of 20% and 40%. At this video speed, it was possible to see the relative cavitational energy or bubbles emanating from the phaco needle. My first observation was of little if any cavitational effects with the straight needle at 20% power and only faint amounts at 40%—although the needle's movement could be seen. In contrast, the bent needle displayed more movement and robust cavitational bubbles on the lateral aspect of the needle tip at 20%, reflecting the transversal movement, which increased with power rise to 40%.

Even more interesting was the simultaneous visualization of cavitational activity at the tip of the bent needle reflecting the longitudinal component of movement, which increased with a power rise from 20% to 40%. To my knowledge, this is the first time that the nonlinear bidirectional characteris-

tic of the Ellips FX has been observed.

The in vitro results may give some insight in understanding my in vivo findings. First, bending the needle seems to improve the cavitational portion of the energy dispersion, and this may explain the relative phaco efficiency seen in the OR. In addition, the effect of increasing longitudinal movement and cavitation with increasing power may explain the significant reduction in occlusionary events and surge seen with bidirectional phaco utilizing Ellips FX. It may also suggest that the straight needle depends more on mechanical energy for its ability to emulsify the cataract.

It would seem ideal to maximize both forms of energy dispersion with the bent tip. It is possible, however, that there are situations where using primarily mechanical energy and reducing the acoustic noise from cavitation may be advantageous.

CONCLUSIONS

This study showed that phacoemulsification using the devices described makes it possible for surgeons to minimize high-grade occlusionary events by adopting a bidirectional transversal phaco technique while still using a straight needle.

Surgeons utilizing straight-tip technology may, however, want to reconsider switching to a bent tip to take advantage of the greater efficiency. Minimizing occlusionary events allows the surgeon to use venturi pump fluidics, making the transition to a bent tip easier because the powerful vacuum allows the surgeon to keep the phaco needle in a central 3.0- to 4.0-mm safe zone due to enhanced followability.

Further research into the phaco needle's design is needed to make full use of different energy patterns and modalities and to identify strategies for lowering overall energy dispersion in the eye. High-speed video technology can provide us with important guidance in this regard. ■

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