Exploring and Understanding the Benefits of Torsional Phacoemulsification

Introduction

The use of an ultrasonically vibrating needle to remove the nucleus of the human lens was introduced by Charles Kelman, M.D. in 1968. Since that time, the vibratory mechanism has remained largely unchanged—the tip of the needle moves forward and backward in a linear direction along the axis of the shaft, just as it always has for the past 37 years. It is a remarkable fact that this methodology has remained virtually unchanged for almost four decades while other technologies, such as aircrafts, automobiles, telephones, and other devices, have advanced so dramatically that their current version bears little resemblance to their first models.

The fact that “traditional” ultrasound has continued to be the mainstay of cataract removal is testimony to the relatively sophisticated original design (fluidics excepted) and the difficulties in altering the electronic and mechanical features of the instrumentation. A new cataract removal energy modality on the INFINITI™ Vision System was introduced at the 2005 meeting of the American Academy of Ophthalmology. Torsional phaco utilizes ultrasonic oscillations of an angulated or curved needle, which dramatically changes both the energy profile of the tip and the reaction of lens material contacted by the vibrating needle. With each oscillatory cycle the distance traveled by the tip is approximately two times greater than the distance (arc) through which the shaft moves. This result is significantly more delivery of energy by the tip to lens material than by the shaft to the surrounding infusion sleeve and incision. Put another way, energy created within the incision by the rapidly oscillating tip is much less than at the distal end. This mode of action represents a significant thermal advantage and permits the surgeon to create a smaller incision because leakage of infusion fluid alongside the ultrasonic instrument is not required to lower its temperature.

The torsional tip does not move forward and backward, therefore there is no repulsion of nuclear fragments during phacoemulsification. This undesirable effect of traditional ultrasound has required surgeons to use methods such as linear power (gradual increase in tip stroke length) and pulse mode in order to interrupt ultrasound and, thereby, permit fluid removal to return the chattering particle to the tip of the ultrasonic needle. They have also used spatulas and other instruments to hold the nucleus against the vibrating tip. All of these remedies are much less necessary with torsional phaco.

Understanding the Physics of Torsional Phacoemulsification

Torsional with Different Surgical Techniques, Post-operative Results and Improved Outcomes

Learning Curve and Transitioning to Torsional

Using Torsional on Dense Nuclei

Pearls for Torsional Phaco

Customizing your Lens Removal

Microincision Surgery Using Torsional

Moderator
Richard J. Mackool, M.D.

Participants
Robert P. Lehmann, M.D.
Kerry L. Solomon, M.D.
Khiun Tjia, M.D.
Sonia H. Yoo, M.D.

Surgical CD Included
Surgical footage and One-On-One Discussions with the Surgeons — See back page

An EyeWorld Round table produced live in New York City supported by an unrestricted educational grant from Alcon Laboratories, Inc.
Richard J. Mackool, M.D.: I’m going to compare torsional phacoemulsification to what I’ll now refer to as traditional phacoemulsification. “Traditional” seems to be the best word to describe the past technology that I think we will be doing with less frequency in the future because of this new, non-traditional phacoemulsification called torsional.

My year-long surgical experience has demonstrated the difference between traditional ultrasound versus the rapidly oscillating torsional movement at 32,000 times per second. It’s also possible to use the OZil™ torsional handpiece, alternating between longitudinal and the torsional motion.

I believe that there are two reasons why it is more efficient in sculpting with torsional phaco. First, it’s cutting with each side-to-side motion, not just the forward stroke. While the torsional frequency is 32 kHz, which is lower than conventional ultrasound frequency of 40 kHz, you will effectively double the frequency that the tip will remove lens material as each side-to-side stroke counts twice, so we arrive at an equivalent 64,000 cuts per second. In other words, it is increasing your cutting strokes.

The second reason why I think torsional phaco is more efficient is although you don’t really see it when you’re sculpting the nucleus, dense nucleus is actually repulsed slightly away from you. Each forward stroke pushes it away. The reason you don’t see it is it can’t go very far. It’s restrained in the capsule, but it can and does repulse slightly away from the tip. So you wind up pushing a little harder trying to get through it. Torsional stroke is side to side so it shears the lens material and doesn’t make it move away from the tip. I think that’s why we’re seeing such great advantages, even during the sculpting process, and, of course, during the nuclear segment removal. Anybody who has done any phaco will immediately see the lack of repulsion as the main benefit of torsional, and it is just off the charts.

Torsional phaco can be combined with a number of infusion sleeves: a 3.0 to 2.75 mm incision utilizing the 0.9 high infusion sleeve, or the new Ultra Sleeve, which fits very easily through a 2.2-mm incision.

I recently operated on the only eye of a patient with an extremely dense nucleus and an endothelial cell count of 412 cells/mm². There was no significant zonular support, and I used the Cataract Support System. The nucleus was a dense red brown, but even so there was simply no chattering. Even with such a marginal cornea cell count and dense lens, the patient’s cornea was clear immediately and remained so. What was particularly noteworthy was the absence of chattering. Even with the patient’s very dense lens, cataract fragments on the tip didn’t bounce away.

I also recently performed a case on another patient with 4+ corneal guttata and fewer than 500 cells/mm². Again, this patient underwent a torsional procedure using a mini flared tip and an Ultra Sleeve through a 2.2-mm incision. I used a standard phaco chop technique, applying 250 mm Hg, to impale and hold the nucleus. I then used 400 mm Hg to remove the nuclear segment. The ability to use these vacuum levels when operating through such a small incision is unique to the Infiniti™ fluidic system.

The thermal benefits of torsional are such that, in my opinion, the patient’s cornea was clear immediately and remained so. What was particularly noteworthy was the absence of chattering. Even with the patient’s very dense lens, cataract fragments on the tip didn’t bounce away.

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Richard J. Mackool, M.D., is director, Mackool Eye Institute, and senior attending surgeon, The New York Eye and Ear Infirmary, New York.
opinion, there's greatly reduced risk of creating an incision burn. We've done thermal imaging studies using infrared thermography and have found that is extremely difficult to create incision temperatures approaching those necessary to burn the incision.

The simplest way to make phaco easier is to use tight, non-leaking incisions. The easiest way to make it very difficult is to have leaking incisions. There are no disadvantages and almost no learning curve to torsional. It has a pretty impressive list of advantages. Those advantages will become obvious to the surgeon who takes up this technology. I would say that the surgeon will see the advantages in a very short period of time, if not within the first few cases.

Robert P. Lehmann, M.D.: Dr. Mackool's surgical cases show that there's very little movement of the torsional tip in the eye because the material seems to flow to the tip better with torsional than with any other instrument I've ever used, from the AquaLase® Liquefaction device to NeoSonix® handpiece to standard phaco. Lens material just flows into the tip and is emulsified. Also, I found that my next quadrant actually comes to the tip better and you rarely need to reposition the tip to attract the nucleus or manipulate nuclear fragments with a second instrument. Nuclear followability is unparalleled.

Dr. Mackool: When nuclear fragments are not repelled and dispersed, there is less chance that small fragments will get trapped in the angle, capsular fornix, or sulcus. You're probably less likely to leave material behind.

Kerry L. Solomon, M.D.: I think it's more efficient because you actually are now using a totally new movement that is cutting with both directions of tip movement. The tip moves in a side-to-side motion, so it is in constant contact with nuclear material.

In reviewing cases, we can see lack of dispersion of nuclear material. It's evident when you first start emulsifying or harvesting your lens material there's really no

**Torsional with Different Surgical Techniques. Post-operative Results and Improved Outcomes**

Dr. Solomon: In a nutshell, my post-operative outcomes have been excellent. I've been very comfortable with my techniques and my corneas are clear. My standard ultrasound procedure is the Infiniti™, with a 1.1-mm Kelman® flared tip. The move for me to torsional was one that, at first, I was somewhat skeptical about, because I was already achieving great results. I was really looking forward to trying it, though, because I think there are a number of very clear advantages for why this ought to be the direction we go.

As we've discussed, torsional phaco allows less risk of thermal injury, less dispersion of nuclear fragments, and improved efficiency. Speed is not its only efficiency; safety is as well. These clinical advantages are huge. If you look at the trend of where we're going with our surgical techniques, we're going toward smaller incisions. If we go toward smaller incisions, then we need to be more concerned about thermal risk.

Certainly, we try to introduce less irrigation fluid into the eye, so we need to be concerned about efficiency, maintaining as efficient a system as possible. Also, we want to be able to keep patients' corneas clear. To me, that depends on turbulence and better efficiency at the tip, with less dispersion of nuclear fragments. I think the motion of the tip generates significantly less energy simply because of the way it oscillates, rather than backward and forward, which already has been mentioned.

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Kerry L. Solomon, M.D., is associate professor of ophthalmology, Medical University of South Carolina, Charleston.

I think torsional is more efficient because the tip cuts with both movements. Because the material stays at the tip, you don’t have to go around the anterior chamber and chase it.

Again, if we’re progressing toward smaller incisions, we don’t want to have to sacrifice operating efficiency. We don’t want it to be less safe, cause thermal injury, increase capsular tear rates, or have other downsides. We don’t want huge learning curves nor do we want to slow down our procedures. Ideally, we’d like to be able to have a learning curve that’s minimal or zero and be able to maintain efficiency while we create smaller and smaller incisions.

This torsional technology is ideally suited for that. That has been my experience as I have transitioned from a 3.0-mm incision with my 1.1-mm flare, down to a 2.6-mm using the 0.9 tapered tip and to a 2.2-mm incision with a new mini flared tip that is under evaluation. This has all resulted without me needing to modify my surgical techniques or procedures.

I think this technology lends itself to all-comers. For divide-and-conquer surgeons, I have found this to be very effective. You get a slightly wider trough because of the action of the tip, which really causes no downside, yet the upside is efficient quadrant removal when it comes time to harvest the lens quadrants. For stop-and-chop surgeons, again, you get a slightly wider trough because of the torsional action but very efficient quadrant removal.

For pure chop surgeons, I think you can do one of two things. I’ve experimented a bit with using traditional ultrasound to quick chop and make the initial pieces. I have gotten better purchasing power with traditional ultrasound for that because the back-and-forth movement helps me to penetrate and imbed the phaco tip into the nucleus. I then change to a quadrant removal setting and use 100% torsional phaco, except for very dense lenses where we may introduce some small percentage of ultrasound for quadrant removal.

As for cataract density, soft lenses, you can aspirate them out. I can have an absolutely watertight seal on my phaco incision and a watertight seal on the paracentesis incisions (or almost watertight) and find the efficiency is huge. On soft lenses, torsional phaco is incredibly safe. The chamber doesn’t move at all and there is little or no energy whatsoever.

In summary, I think you can use your fluidics any way you’d like because the efficiencies of it are such that it’s going to shine both with a low flow and higher flow settings. I tend to prefer the high-flow phaco aspiration technique. However, as I’ve moved toward smaller incisions, I have reduced my fluidic parameters based on incision size and the particular tip that I use. For example, I found I can use slightly higher parameters with a mini-flare tip compared to the tapered tip.

I think torsional gives us less thermal risk and more efficient removal of lens material. That really means less repulsion, and no forward-backward movement of the lens material or the tip itself. The material just stays right at the tip for quick movement. It offers better fluidics, which is not to be
Sonia H. Yoo, M.D.: The main technique I’ve changed to be able to use torsional ultrasound is using 0.9-mm angled Kelman tip instead of the 1.1-mm straight flare tip.

The change to torsional phaco and the different tip design have required some adjustment in my surgical technique. I also have been going from pulse or burst mode in my quadrant removal with traditional ultrasound to a continuous torsional ultrasound mode to maximize the efficiency of this new tip movement.

In one of my first cases, the patient had a fairly dense 3+ cataract. At that time, I wasn’t quite used to using the 0.9-mm tapered tip. It required me to make more passes than I was used to with the 1.1-mm flare tip. However, having a thin groove allowed me to crack the nucleus a little easier, particularly with these denser nuclei. I found it was fairly easy to occlude the tip and bring the pieces right to me, thus keeping the phaco tip in the center of the central safe zone.

I did have to make a little foot adjustment with traditional ultrasound. I would move quickly into foot position three and just engage the nuclear piece with a low amount of ultrasound. But with torsional, I found that just holding it in foot position two, really turning the tip of the needle flush with the nuclear piece, and then building occlusion at the top of two was all I needed. This allowed me to move the piece and activate torsional ultrasound. Also, I didn’t get that repulsive effect you can sometimes see with traditional ultrasound. I automatically started removing lens material.

A later case in which I used torsional was another fairly dense cataract in a patient with a moderately dilatable pupil in the diabetic eye and a bit of a floppy iris. I made somewhat of a transition. I had to take a little bit more time to do that initial sculpt because I’m generally a stop and chopper. However, the smaller groove made the cracking easy, and I was again very impressed with that the pieces would just come to the tip and stay at the tip. I didn’t have to reach or fish for them in the periphery. I could just stay in the middle of the eye.

I also found that there seemed to be less chatter of the pieces than I found with traditional ultrasound. The only time I would get occasional loose particles was when my paracentesis was a little too large, so I had some egress of fluid out of the paracentesis, and occasionally I would get a little chip in the nucleus out at the incision. I think that was more a function of my second port incision size than anything else.

Then, I used it on a soft lens. I was using the pre-chopper in a soft lens, just turning it upside down, and was able to crack it pretty easily. The main part of the technique that took a little bit of adjustment for me was rather than going right into phaco three and engaging the piece. I could just hold at the top of two and engage the piece that way. Then everything would stay right at the tip.

Because I am at a teaching institution, I have the opportunity to operate with fellows on my surgical days. My fellow was easily able to use the torsional as well. We experimented with quick

Learning curve and Transitioning to Torsional

Dr. Mackool: Another situation I’d like to comment on is a floppy iris. When you operate with a tight, sealed incision, you don’t have turbulent flow. These floppy iris syndromes usually associated with Flomax (Boehringer Ingelheim GmbH, Germany) are much easier to manage. You can use lower vacuum levels, as we discussed. That tends to keep the pupil more dilated and the iris is less likely to be attracted to the tip. There are a lot of advantages in these Flomax-type cases for using this kind of sealed incision, lower flow, and vacuum, yet still remove the cataract efficiently with torsional energy.
chopping and stop and chop, and the torsional worked very efficiently for all these different kinds of maneuvers and was very safe. From a teaching standpoint, I’m very happy with the safety of this torsional ultrasound.

**Dr. Mackool:** You commented about using torsional in continuous mode. Continuous phaco during removal of nuclear segments has become more or less passé with the vast majority of surgeons. In other words, traditional ultrasound is usually purposely interrupted because there’s a tendency for particles to chatter away. If you interrupt ultrasound, you can reattract nuclear material to the tip, and then the next burst comes along and hits the nuclear segment, emulsifies it, and the process is repeated. With torsional ultrasound, you don’t get chattering.

Torsional doesn’t have the repellent force, so if you interrupt delivery of energy, the removal process stops without benefit because the piece is still on the tip. Delivery of torsional power is linear, meaning greater torsional tip excursion. Excursion occurs as the foot pedal is depressed further. The use of continuous mode is not so much a learning curve as a new way of thinking about how to apply ultrasonic energy with torsional compared to how we apply it with traditional ultrasound.

**Khiun Tija, M.D.:** Touching upon the issue of teaching, you mentioned the increased margin of safety. I also teach residents. Although I have never experienced any wound burns myself, I have witnessed two very difficult wounds, after phaco by a resident, which were almost impossible to close. I think that type of burn is very unlikely when torsional is used. That’s a great comfort to residents, as well as to the teacher.

It also decreases the rate of posterior capsular ruptures. I’ve experimented with vacuum and aspiration flow settings with torsional. I found you can lower vacuum settings and aspiration flow settings significantly, by as much as half. But, even with these low flow and vacuum parameters, you still have much more efficiency compared to traditional longitudinal ultrasound with more aggressive fluidic settings. Because of lower vacuum and aspiration flow, you have an enormous margin of safety and rock-solid anterior chambers. That allows for very easy quadrant removal by residents without the fear of getting a capsule up to the tip after occlusion break. With this technology, that is simply eliminated.

You also experience reduced chatter of lens material because the forward stroke of longitudinal ultrasound is indeed eliminated. In addition, when torsional ultrasound is used, the surgeon is not chasing particles anywhere around the anterior chamber. This technology gives residents control of the procedure. Their self-confidence grows enormously when they use this. This technology will be a major leap forward in cataract surgery training of residents. It will also increase the quality of their cataract surgery.

**Dr. Solomon:** One of the barriers to bimanual surgery, even for experienced surgeons, has been a long and steep learning curve. If we look at how to make phacoemulsification better, we want to make it more efficient and safer.

By being able to take a fellow, a resident, an average practitioner, or an experienced practitioner and require essentially little to no learning curve to change over to torsional is huge. We have residents who use torsional and my other associates have used torsional. There’s little to nothing new for them to learn in order to successfully use the technology.

We’re okay lowering parameters within the eye if we want to or need to, or as we go to smaller incisions, as long as the action of the tip is kept efficient. I think the efficiency with torsional is greater than with ultrasound, even with lower parameters. You can use lower flow and lower vacuum, higher flow, higher vacuum, soft lens, and dense cataracts, with very little learning curve.

**Dr. Mackool:** At our Ambulatory Surgery Center, we have introduced torsional to a number of surgeons; some of them do phaco chop and some do divide and conquer. Every surgeon commented, “I want to use this on
every patient. This has created an interesting problem for us. We’ve got to get more of these machines because we have four ORs and only two Infiniti™ machines equipped for torsional.”

Dr. Lehmann: Dr. Yoo has alluded to something that she noted using a 1.1-mm tip. With torsional phaco, we use a smaller tip, and that’s probably the only change that I observed. I find that to attract that first quadrant after I’ve made a crack is different with torsional. Because the torsional tip has less repulsion, it will just go right into the nucleus. It will just shear the lens material and remove the nucleus. What you want to do is attract that first piece of nucleus into the central zone of safety.

I’ve actually moved to more pre-chopping in the moderately dense nuclei. I’m thinking about using Dr. Mackool’s stop-and-chop technique and cracking the lens into five or six pieces, which I’ve never done. I’ve always grooved first and then done a bimanual in situ phaco fracture technique. The efficiency with which the tip just erodes the nucleus is almost like magic. Dr. Solomon, made a comment about how it just vaporizes the tissue; once that tissue starts to come to the center of the zone of safety, the center of the eye, it’s just complete followability, which is wonderful.

Dr. Tjia: Another observation is production of lens milk—especially during sculpting with continuous torsional ultrasound. I think the reason it occurs is that the transverse motion of the tips prevents emulsified milk to escape through the constantly occluded tip end. Once a surgeon repositions or withdraws the tip, it will egress very easily.

Dr. Mackool: Yes, and that would be very different than seeing this lens milk during sculpting with traditional ultrasound. With traditional ultrasound, the surgeon thinks, “Oh, the tip is completely obstructed. There is no flow anywhere in the eye. I want to be careful that I don’t create an incision burn.” This is not the case with torsional. Lens milk is a curiosity of this new movement, and it is not a problem.

Dr. Solomon: Dr. Mackool, you brought up a point where you mentioned endothelial cell counts and how clear the corneas looked. I think when you look at the studies of fluidics with torsional, we should be able to see less turbulence, perhaps greater retention of viscoelastics, better for the cornea and endothelial cells in terms of corneal production.

Dr. Mackool: We have a study under way now to compare our cell-loss rate that, I’m happy to say, had gotten quite low with traditional ultrasound performed through a sealed phaco incision. Torsional allows sealed incisions, just like I’ve been used to using with my Mackool system; however, there are additional advantages such as less repulsion and turbulence.

Using Torsional on Dense Nuclei

Dr. Tjia: As Dr. Mackool has already discussed, softer lenses, and some medium lenses, can be taken out with just vacuum alone, without any ultrasound. On denser nuclei that was not the case. I think torsional is of immense importance in those cases.

Summarizing the benefits of torsional are the low tip movement and the reduced thermal friction at the wound site stressing again the potential for thermal injury even with 100% continuous torsional ultrasound is actually almost eliminated even on the densest of lenses.

The other major advantage is the very effective transverse motion and, therefore, continuous contact between the tip and the nucleus. As already said, because of maintaining the occlusion all the time, the reduced flow and turbulence in the anterior chamber keeps our endothelial cells in much better shape. That is

Greatly improved thermal safety profile is beneficial when sculpting on dense lenses

Lens milk can occur during torsional emulsification

Torsional increases efficiency and reduces turbulence even on dense nuclei
not only because of the reduced turbulence but also because we keep the protective viscoelastic in the anterior chamber much better than if we use traditional ultrasound.

I have compared traditional ultrasound and torsional in numerous cases. In one case, however, I was confronted with a pretty tough nucleus and a mature cataract. I used traditional ultrasound and linear burst mode, with U.S. power up to 60% and a maximum duty cycle of 20% for quadrant removal.

I didn’t schedule this patient for torsional because I didn’t actually think that it would be that hard. But after three quadrants using traditional ultrasound, I asked for a torsional handpiece.

The last quadrant was emulsified at a stunning speed and the difference in efficiency between longitudinal and torsional ultrasound was striking.

Knowing what is possible with torsional puts us in a whole different ball game.

Although other tips can work, my personal experience has been best with a tapered Kelman, 45 degrees. I have had some cases where alternating torsional and longitudinal can be beneficial. In most cases, 100% continuous torsional is just excellent. With very hard nuclei, torsional ultrasound has made my work as a cataract surgeon a whole lot easier.

I had an early case about a year ago with a really dark brown nucleus. This would have scared me before torsional. It was sticky, cheesy, rubbery, and hard. During sculpting this extremely hard nucleus I wasn’t afraid of burning the incision, even with 100% continuous torsional.

With a really dense and rubbery nucleus like this one, simple cracking is impossible, and I had to perform slow chop. After every successful chop, emulsifying the brown nuclear pieces was strikingly efficient and easy. With traditional ultrasound it would have been extremely difficult and time consuming to remove this cheesy lens material with a serious chance of corneal decompensation.

The outcome of this case was excellent, thanks to torsional technology.

Dr. Lehmann: The rubbery, Coca-Cola cataracts you described are in patients with poor dilation and weak zonules. In many cases these are managed with much greater ease using torsional. This fact has really made my operating room day far less stressful because torsional is safer, more efficient, and not just in those cases for all cases. You’re not manipulating nuclear fragments as much. There is less repulsion and therefore less chatter and I think you’re stressing the zonules and your cardiac circulation much less.

Dr. Yoo: I sometimes use the 45-degree tip, too. I went from the 30- to 45-degree tip and thought it worked very efficiently. It was very quick removing the quadrants in a high vacuum mode.

For many of these dense cataracts, we used NeoSoniX before. The difference surgeons get with NeoSoniX versus the torsional ultrasound in terms of lack of repulsion makes such a difference. Ergonomically, the handpiece is much lighter and it works more efficiently.

Khiun Tjia, M.D.
Isala Clinics, Zwolle, Netherlands
Pearls for using torsional phaco

Dr. Tjia: There are some situations where a phaco tip has the tendency to lollipop or Swiss cheese the nucleus; the nuclear quadrant will be stuck onto the phaco tip and it cannot go in because it’s stuck by the sleeve. A 45-degree tip works a bit easier than the 30-degree tip because a 45-degree angled tip makes the quadrants tumble more easily than a 30-degree one. Another option is to add intermittent short bursts of longitudinal ultrasound. Because of the short repulsive effect of longitudinal ultrasound, the quadrant will be repositioned and will facilitate the quadrant to be tumble and emulsified without being lollipopped.

Surgeons have to be aware that the quadrant should be really free and mobile and not be blocked by the capsulorhexis edge, iris, or cornea. It should be able to move freely. If it cannot move freely, it cannot tumble further and be emulsified.

Dr. Mackool: Even if you perform traditional ultrasound, you really want your quadrants to be free so that stress is not transmitted to the capsular sac and zonule when you try to remove a quadrant that’s still attached to the rest of the nucleus.

Customizing your Lens Removal

Dr. Lehmann: With the Infiniti Vision System’s launch we had AquaLase®, standard phaco, and NeoSoniX. I see torsional pretty much replacing NeoSoniX and traditional phaco in my practice. However, I think there is still a role for AquaLase.

We’re seeing a wider variety of lens densities now coming into play because refractive lens exchange with presbyopic lens correction has become a large part of our practices. We have some new anatomical variations recognizing the associated problems that we see with intra-operative floppy iris syndrome and Flomax. Also, an increasing occurrence of post-refractive patients, post-LASIK and RK patients coming in that are in the baby boomers, developing their cataracts. Increased patient expectations are a result of the presbyopic procedures. Those overall higher expectations come with no shot, no stitch, no patch refractive cataract surgery.

The improvements have been monumental, and we see many younger patients coming in now wanting cataract removal at an earlier stage. Depending on the geographic area of your practice, there are still a large number of patients that come in with very advanced, very hard cataracts. I think it is in the patients’ and surgeons’ best interest to optimize the patients’ results by performing whatever technology is safest and most efficient for removal of their lens cataract type.

I use AquaLase for all of my refractive lens exchange cases and for patients with primarily posterior subcapsular cataracts, and softer, up to a 2+, dense nucleus. I think there are some distinct advantages to AquaLase, even over torsional, because the metal needle within the confines of the capsular bag is still not as smooth, delicate, and safe to the posterior capsule as the smooth polymer AquaLase tip.

We went through a time when we initially sculpted and cracked and now implement a pre-chop with greater efficiency. The result is that AquaLase, now with pre-chop, is much more efficient and quicker in terms of speed and safety in those softer nuclei. The tip is more capsule-friendly than the metal needle. Pre-chopping allows me to predetermine a case that might be good for AquaLase, or might not be, and if I have a problem cracking the posterior plate with torsional increases nuclear followability

Using continuous torsional increases efficiency of emulsification
the pre-chopper, I will simply use torsional.

If we consider efficiency, as Dr. Solomon mentioned, a function of not only time and speed, but safety, I think that there is still a definite role for AquaLase.

Again, I use torsional for my medium to dense lenses because torsional has greater efficiencies that I think will quickly become evident to surgeons. The repulsive forces of longitudinal phaco will eventually be repulsive to surgeons that have the opportunity to use torsional. As Dr. Mackool mentioned, there is no downside. There is very little learning curve and no safety tradeoff. Torsional is just more efficient. There is less turbulence and better followability. I think it was probably Dr. Kelman that at some point in the past made a comment that the ideal tool we’re looking for is an instrument that we can put in the eye, engage the cataract, and the cataract material will be drawn to it and eliminated. Torsional is as close as it gets to that ideal today. Dr. Solomon has used the term “vaporize,” and that, perhaps, doesn’t give just the right picture that we want to portray. But literally, the cataract tissue is removed from the eye so smoothly and efficiently that there is more retention of viscoelastic, and a greater margin of safety, and we see incredible outcomes day one.

Harkening back to the patient population that we have now with greater expectations, this is a requirement. This is no longer a luxury. But we’re able to achieve these kinds of outcomes more easily and reliably with torsional.

Customization is important. If a surgeon has the Infiniti available, certainly venture out and use AquaLase in the soft cases. I do not think necessarily the torsional technology is as safe within the confines of the capsular bag as the smooth AquaLase tip, in the very soft lenses particularly. In refractive lens exchange, I’m sticking with AquaLase—at least for now. If all you had was torsional versus traditional phaco, I will predict we are going to see a 100% conversion of physicians who try the technology of torsional and appreciate all of its advantages.

Dr. Tjia: I agree about AquaLase having a very definite role to play in lens surgery. As you indicated, refractive lens surgery will become more important. The remote action of the AquaLase spray, the power-washing of the capsule, is something no other technique can do.

**Microincisional Surgery Using Torsional**

**Dr. Mackool:** Dr. Tjia, where are we now with incision size? How low can we go?

**Dr. Tjia:** If we are talking about microincisional cataract surgery, I think it’s still a cataract implant issue. What incision size is needed for a specific implant? There are, specifically in Europe, more small-incision, microincision, implants available. Whether they are very good or have a long-term follow-up is questionable. I think that is not yet the case.

If we are talking about proven good quality implants, then the AcrySof® single-piece has been implanted about over a year through smaller incisions. I think the smallest post-injection incision size documented is in the order of 1.9 mm. Specifically, a surgeon in Japan, Dr. Akahoshi, has done thousands of those cases, but his technique is potentially a bit more demanding than is possible for every average surgeon. At present, 2.2 mm is a good incision size to rely on.

Until recently, microincisional surgery was bimanual phaco with longitudinal ultrasound. Several companies have promoted this. In fact, every single machine can do it.

We have already discussed the drawbacks of traditional ultrasound heat production, repulsion by the longitudinal stroke, and the reduced irrigation flow. Another major issue, distortion of the 2.2 mm incision by the rigid metal cannulas, withheld me from pursuing bimanual phaco.

Manipulating the hard cannulas within the tight incisions certainly distorts and compromises the incisions. Clear corneal incision is already controversial because of the possible increased endophthalmitis risk. That’s certainly not better with distorted wounds. Micro-coaxial phaco with a soft and mal-leable Ultra sleeve doesn’t distort the incision, especially three-step traditional wound construction, which seems to be very strong and safe. These three step wounds, after applying point pressure just behind the wound lip, remain watertight. A properly constructed non-distorted incision should be 100% safe, but with microcoaxial phaco it should even be stronger, because of the smaller size of the incision.

I created a video that shows a comparison, within the same procedure, of traditional versus torsional ultrasound. In the clip, you see a 2.0 mm incision, micro-coaxial phaco with an Ultra sleeve.

First I used traditional ultrasound and pulse mode, and a reduced aspiration flow of 30 ml/min (instead of
**Bimanual versus Micro-coaxial Cataract Surgery**

by Richard J. Mackool, MD

Dr. Mackool: I want to compare bimanual, so-called microincision cataract surgery (MICS), with micro-coaxial phaco. With the bimanual technique, surgeons generally create two incisions of 1.5 mm. With the Ultra sleeve and torsional phaco, they can create one incision that can be anywhere from 1.8 to 2.2 mm and will not leak during phaco.

With the current MICS technique, an additional incision is required for IOL insertion. Most surgeons make an additional incision for this because they essentially distort the first two incisions so much that they’re afraid that enlarging them will make them incapable of self-sealing. That adds another 2.5 to 3 mm. With micro-coaxial phaco using the Ultra Sleeve, no additional incision is needed for IOL insertion.

With bimanual MICS, the phaco incision must leak in order to cool the needle unless the surgeon uses a special Mackool tip for MICS through a non-leaking incision. The majority of surgeons using other instrumentation from other companies perform MICS with an incision that leaks. With micro-coaxial phaco with the Ultra Sleeve or any other sleeve you care to use, the incision can be watertight and it should be. There’s no reason to have it leak.

With the bimanual procedure, there’s a pretty steep learning curve. Different instruments are required. Many surgeons have reported that they find no advantages with it, its market penetration has been minimal, and there are apparently good reasons for that. With micro-coaxial phaco using the Ultra Sleeve, or any other sleeve for that matter, we’ve found no learning curve. These are compelling arguments in favor of small, micro-coaxial surgery compared with bimanual surgery.

When an incision is smaller, and in the case of smaller coaxial tips, we certainly have smaller incisions, there’s less infusion capacity, meaning less flow can be delivered to the eye. When that happens, lower flow and vacuum settings must be used compared to procedures done with a larger incision and larger infusion sleeve. This could reduce efficiency if everything else remained the same. However, because torsional doesn’t repel nucleus, high flow and vacuum are not required to attract and hold it. Therefore, the efficiency of the procedure doesn’t suffer despite the fact that reduced flow and vacuum settings are employed. That’s a huge plus.

Another advantage is the undeniable benefit of a malleable (silicone) infusion sleeve. With the bimanual technique, the infusion cannula and the phaco tip are rigid. These round, unyielding instruments undesirably stretch and deform the incisions. If you put an infusion sleeve on them, they would require a larger incision.

45ml/min with a micro sleeve and 2.75mm wound. There is some chatter, due to the reduced flow. In the second quadrant, I used Burst mode with a very low duty cycle without significant chatter. It was gradually emulsified. But the third and fourth quadrants I removed by using 100% continuous torsional ultrasound with far greater and striking efficiency, even with the reduced aspiration flow. This represents a huge difference in surgical effectiveness and lack of repulsion compared to traditional ultrasound.

At the end of this procedure I had a 2.1-mm final incision size, and without having stromally hydrated the wound, and without any significant wound stretch. It is 100% watertight.

In conclusion, the superb efficiency and intrinsic safety of torsional ultrasound will make the transversion from 2.8mm coaxial phaco to 2.2mm micro-coaxial phaco very easy.

Cataract surgeons now have the option of performing safe and efficient Micro Incisional Cataract Surgery with proven high quality 6 mm optic IOL injection.

Dr. Mackool: I’d like to thank each of my distinguished colleagues for sharing his insight and experience regarding torsional phacoemulsification with our colleagues. It’s obvious that the entire panel is convinced that this technology dramatically improves the phacoemulsification procedure.
Included with this supplement is a CD that contains surgical footage and detailed discussion of many important aspects and applications of the torsional technology. All five participants discuss, use, and demonstrate torsional phaco so you can better visualize the exciting potential and benefits of this new and unique lens removal modality.

This CD was produced and directed solely by Alcon Laboratories, Inc., and was not taken from this EyeWorld Supplement.

“The efficiency with which the tip just erodes nucleus is almost like magic.”

Robert P. Lehmann, M.D.