Surgeons know to avoid touching the capsule with a phaco needle during phacoemulsification, but even if they follow that rule capsular damage can still occur. New research identifies one way to reduce such complications.

The expanded utilization of torsional ultrasound energy by phacoemulsification system applications such as the OZil Intelligent Phaco (IP, Alcon, Fort Worth, Texas) may help reduce overall complications, especially failures of the posterior capsule, according to a study by Richard Mackool, M.D., the Mackool Eye Institute, Astoria, N.Y., and Robert Osher, M.D., Cincinnati Eye Institute, Ohio.

This study of the impacts of phaco energy on the posterior capsule indicated that phacoemulsification systems that use larger amounts of longitudinal ultrasound power may increase the risk of rupture. The study compared the likelihood of posterior capsule tears in porcine eye models where either longitudinal or torsional energy was utilized. In 36 crystalline lens removal trials split between 17 torsional cases and 19 longitudinal cases, the posterior capsule was aspirated to occlusion and then linear ultrasound was applied until a posterior chamber tear occurred.

The study found that longitudinal ultrasound tip motion consistently tore the posterior capsule at lower ultrasound power than torsional ultrasound tip motion. The findings could have safety implications for many surgeons who blend longitudinal and torsional ultrasound for cataracts in order to prevent clogging that can slow phacoemulsification. In addition to concerns that such regular use of longitudinal ultrasound energy may be excessive in soft cataract cases, the research indicates that its use should be limited.

"The expanded utilization of torsional ultrasound energy applications such as the OZil Intelligent Phaco may help reduce overall complications"—Richard Mackool, M.D.
minimized for safety reasons.

Among the newest phaco applications to incorporate that concept is the OZil IP, which applies longitudinal energy only when an occlusion is imminent.

“OZil IP improves cutting efficiency by its ability to continuously remove nuclear material without the development of either intermittent obstruction or the use of excessive longitudinal tip vibration that can cause chattering of particles and endanger the endothelium,” Dr. Mackool said. “The absence of chattering causes particles to remain near the tip and reduces the possibility that they may be propelled into the periphery of the anterior chamber where they may be sequestered in OVD, the filtration angle, etc.”

Dr. Mackool noted that the reduced use of longitudinal energy by the OZil IP application also allows continuous followability of lens material because repulsion of nuclear material does not occur.

Another protective benefit of OZil IP’s approach to the use of ultrasound energy includes better protection of the corneal endothelium during phacoemulsification.

“Because of the absence of chattering and the followability of lens material, reduced amounts of BSS PLUS (balanced salt solution, Alcon) are required for the procedure,” said Dr. Mackool. “These factors act in concert to protect the corneal endothelium during the procedure, thereby reducing endothelial cell loss.”

Dr. Mackool has found further corneal endothelium protection is provided by combining the OZil IP application with sodium chondroitin sulfate and sodium hyaluronate (VISCOAT, Alcon).

“Even with flow rates greater than 30 cc per minute, VISCOAT remains in the corneal dome, whereas OVDs that do not contain chondroitin sulfate do not,” Dr. Mackool said. “In my opinion, the combination of VISCOAT and IP are the two most important aspects of the phacoemulsification procedure that positively impact preservation of the endothelium.”

The performance benefits that come with the OZil IP’s reduced use of longitudinal power have not come at the price of more work for the surgeon. In fact, Dr. Mackool has found that the new application has reduced the length of his phaco procedures.

Additionally, Dr. Mackool has found no learning curve with the new application, which lends itself well to his preferred soft shell technique and his aspiration of the viscoelastic from the surface of the nucleus before beginning phacoemulsification.

“This should be done regardless of the phacoemulsification system that is employed,” Dr. Mackool said.

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Summary
In the porcine eye model, longitudinal US tip motion tore the PC at lower US power than torsional US tip motion.
The twin goals of reduced surgery time and reduced energy used in phacoemulsification procedures got a boost with the combination of the OZil torsional handpiece (Alcon, Fort Worth, Texas) and the Intelligent Phaco (IP) software for the INFINITI Vision System (Alcon).

Those improvements were found in a comparison of OZil system cataract procedures performed both with and without the OZil IP. The study originated from the impression of Bradley Black, M.D., assistant clinical professor, department of ophthalmology and visual sciences, University of Louisville, that the OZil IP was reducing both the required time and energy when he began using the system in September 2009.

Dr. Black’s study compared time and energy used in dense nuclei cases by both the established OZil system and the newer OZil IP, and it confirmed the newer technology reduced both the time in the eye and energy usage. The study of the same two OZil systems used by the same surgeon found OZil IP’s dense nuclei cases used an average of 27% less energy. The cumulative dissipated energy (CDE) was 19.98 units on average in OZil system patients but dropped to an average of 14.62 units in OZil with IP patients. “It was pretty dramatic,” Dr. Black said.

“I was looking forward to OZil with IP when it came to removing the quadrants after chopping or dividing a really dense cataract, and I was not disappointed,” Dr. Black said. “It was a night and day difference in dealing with those types of cataracts.”

The improvements in time and energy usage stemmed from the design approach of OZil IP that sought to maximize cutting efficiency, improve the fluidics’ dynamics, and keep nuclear material on the tip. The result was less turbulence in the anterior chamber and better protection for the endothelium.

The impact of the OZil IP was also seen in post-op visits, where patients appeared to have even clearer corneas than they did with the OZil system.

“We had clear corneas before but any time you make even a minor improvement, when you look at a large number of patients—particularly patients who might have a compromised endothelium to start with, such as Fuchs’ endothelial

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dystrophy—you will see even less corneal edema, corneal thickening, and corneal striae,” Dr. Black said.

The new system also appears to have addressed one of the concerns some surgeons have raised with the OZil system: occasional flow interruption. Although Dr. Black never experienced the problem, some surgeons who use static aspiration and vacuum settings with OZil have seen the tip occlude and clog slightly, particularly in dense nuclei cases. Occlusion raises the risk of increased heat energy and prevents the flow of material through the tip, and stagnation can result in the anterior chamber.

To prevent such interruptions in flow and diminished followability, the OZil IP uses short bursts of longitudinal energy when a vacuum threshold has been met. This feature minimizes the repulsion of the fragments at the phaco tip and minimizes heat buildup, which can come from a higher level of thermal energy produced by longitudinal energy, compared to torsional energy.

“OZil IP allows me to utilize longitudinal energy without the negative side effects,” Dr. Black said.

“For me it has really made a difference in the dense cataracts in helping to remove the quadrants and pieces of nuclear material. The followability has been improved over OZil alone.”

The impact of the design changes provided by OZil IP may include a reduction in the need for a second surgical instrument in the eye. Some surgeons have told Dr. Black that they need to use a guide instrument to keep fragments of dense nuclei from falling off the side of the phaco tip. This improvement is especially important if surgeons use a one-hand technique, such as the pre-chop approach utilized by Dr. Black.

“Some surgeons tell me that they hardly even use the second instrument now that they have the OZil and the IP upgrade because they hardly need the second instrument, and if they are using the second instrument it is to hold the posterior capsule back when they are removing the final fragments of the nucleus.”

Dr. Black urges surgeons to entirely eliminate the second instrument, which can leave the chamber more stable because it removes a second port of egress for fluid.

Additionally, Dr. Black said new surgeons can get good results from the OZil IP system if they start out with very moderate settings. He suggested using 95% of occlusion, short bursts of 7 to 8 milliseconds, and percentage of phaco power at .8. As surgeons take on denser cataracts, they should lower their systems’ thresholds to allow for more longitudinal energy that prevents occlusion.

Then, as surgeons become more experienced with OZil IP they can identify the settings that work best for them.

“After I got used to IP and started playing around with the parameters I was able to become opportunistic and maximize the settings of the IP to reduce the phaco energy and allow the short bursts of longitudinal energy to work for me and not just prevent occlusion,” Dr. Black said. “I played with the settings until I came up with those that maximized efficiency, especially in the more dense nuclei.”

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**Clinical Results**
- Less impact during sculpting or formation of grooves
- Less impact with softer nuclei
- Less dramatic effect for already phaco-efficient surgeon
- Marked reduction in op times for lower volume surgeons

**IP individualized for surgeons**
- **Desired goals with IP**
  - **Minimalist**
    - Surgeon does not want to use longitudinal unless absolutely necessary
  - **Opportunist**
    - Surgeon utilizes longitudinal energy to improve efficiencies and yet avoid damaging side effects of repulsion & heat
- **Contra-lateral eye study (N=13)**
  - Non-aggressive “minimalist” settings
    - CDE=15.42
  - Maximized “opportunist” settings
    - CDE=13.52
A new phacoemulsification system software upgrade was found to reduce occlusion time in cataract cases through improved followability, which could lower the overall risk of wound burns and reduce BSS-related endothelial edema, according to Robert J. Cionni, M.D., medical director, the Eye Institute of Utah, Salt Lake City.

Dr. Cionni examined the ability of one of the latest torsional phaco system upgrades—OZil IP (Alcon, Fort Worth, Texas)—to decrease repulsion and improve followability.

To quantify any improvements in repulsion and followability provided by the new technology, Dr. Cionni tracked the average time in occlusion while in footswitch position 3, the length of the average longest occlusive event, cumulative dissipated energy (CDE), and BSS irrigating solution (Alcon) use among two groups of 61 cataract patients treated either with or without the new software enabled.

In each area examined, Dr. Cionni’s research identified improvements for patients treated with the software upgrade. For instance, the mean CDE dropped from 11.02 in patients treated without the upgrade to 9.97 in patients operated on with the new software.

Average occlusion time likewise dropped from 0.99 seconds among non-upgraded phaco system patients to 0.48 seconds in OZil IP-treated eyes. The average longest occlusive event was shorter in eyes treated with OZil IP, dropping from 0.42 seconds to 0.23 seconds.

Dr. Cionni credited these improvements to the approach of OZil IP, which generally relies on torsional energy and adds longitudinal energy only when needed. The upgrade engages longitudinal energy whenever maximum preset vacuum is approached, which repositions the nuclear fragments for torsional emulsification.

“The addition of longitudinal power when needed helps to prevent the lumen from becoming sluggish from lenticular debris and therefore maintains a continuous flow of material through the tip,” Dr. Cionni said. “The result of OZil IP is continued on page 6
Clinical applications for torsional phaco

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less volatility, less BSS used, and less chance for a full occlusive event.”

His research also confirmed that OZil IP required less BSS use. Dr. Cionni’s study noted an average of 35.08 cc of BSS irrigating solution was used in eyes treated with the non-upgraded phaco system, while BSS use was only an average of 27.48 cc in patients treated with OZil IP.

The reduced amount of BSS use stemmed from the overall reduction in the amount of time the surgeon has to spend in the eye, according to Dr. Cionni. The potential benefit of reducing these values was a lower amount of corneal edema found at one day post-op.

“My initial impressions were that adding IP improved followability about as much as torsional improved followability over longitudinal,” Dr. Cionni said.

Such improvements in followability also reduce the associated “chatter,” which can avoid problems with nuclear chips becoming “hung up” in a dispersive OVD.

“The less chatter, the less chips fly away from the tip, and the less likely that chips will become trapped in OVD,” Dr. Cionni said.

Another advantage of OZil IP that Dr. Cionni has indentified while using the upgrade at 95% maximum vacuum is a reduced need to manually reposition the nuclear segments with a second instrument.

“There’s no need to modify your technique at all,” he said.

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Protecting endothelial cells in mature cataract cases

Surgeons have long known that ultrasound energy used in phacoemulsification can endanger the endothelium. But that danger is especially serious in cases of mature or hard cataracts because of the greater energy required to break these nuclei apart.

However, the energy dilemma posed by such advanced cataract cases may not be as imposing as it once was.

New research by James A. Davison, M.D., Wolfe Eye Clinic, Marshalltown, Iowa, using the latest OZil handpiece (Alcon, Fort Worth, Texas) upgrade, known as Intelligent Phaco (IP), indicates that mature cataracts may be removed without damage to the endothelium.

Dr. Davison compared endothelial cell results for 18 mature cataract patients—based on LOCS III gradings—eight of whom were treated with longitudinal ultrasound energy and 10 with OZil IP’s torsional energy interjected with longitudinal energy. An analysis of the pre-op and three-month post-op endothelial cell count changes using the central cornea 50 cell counting method found a mean 4.4% (±4.4%) endothelial cell density loss among the longitudinal energy patients and a mean 2.79% (±3.9%) cell density gain among the OZil IP-treated mature cataract patients.

The findings surprised Dr. Davison, who acknowledged that the study is somewhat limited by its size, because previous studies had found endothelial cell loss of up to 25% after phacoemulsification in such advanced cataract cases.

He credited the OZil IP’s improved protection of the endothelium to its primary reliance on torsional energy, while largely limiting the deployment of longitudinal energy to occlusions at the tip. This limited use of longitudinal energy aims to harness the greater power of longitudinal ultrasound without its negative side effects, which include the repulsion of nuclear fragments at the tip.

“With the IP you are able to control the nucleus a lot more so you don’t have chatter up against the endothelium”

James Davison, M.D.

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lot more so you don’t have chatter up against the endothelium,” Dr. Davison said.

The limited use of longitudinal energy also aims to avoid the damaging effects of heat buildup. Previous research indicates that almost twice as much thermal energy is produced with longitudinal ultrasound compared to torsional phaco.

It was the combination of those design characteristics and Dr. Davison’s preferred surgical approach, the horizontally oriented divide and conquer technique, that he credits with the improved corneal endothelium outcome.

“I always knew that the technique I use is a very gentle technique on the corneal endothelium,” Dr. Davison said. “The bottom line is you can have good results if you use this technique with hard cataracts, and the only way it can be better is if you use the IP because it helps shave the nucleus.”

The findings may bear particular significance in cases with pre-existing corneal complications, such as corneal endothelial dystrophy. The findings should also caution surgeons against combined cataract and corneal procedures where the endothelial cell density post-phaco is less than certain.

“The moral of that story is that you should always do the cataract surgery first and then see how the cornea looks afterward,” Dr. Davison said.

**Results I**

- **18 cases**
  - **8 longitudinal**
    - Age = 73.3
    - Mean LOCS III NO = 4.13, NC = 4.28
  - **10 torsional/interjected longitudinal**
    - Mean age = 73.0
    - Mean LOCS III NO = 4.20, NC = 4.33

**Results II**

- **Longitudinal**
  - Mean pre-op ECD = 2409
  - Mean post-op ECD = 2303
  - Mean ECD difference = -106
  - Mean percentage ECD change = -4.41% ± 4.4

- **Torsional/interjected longitudinal**
  - Mean pre-op ECD = 2459
  - Mean post-op ECD = 2527
  - Mean ECD difference = +68
  - Mean percentage ECD change = +2.79% ± 3.9

*Click on each physician’s photo to view video.*