Comparison Between the Wong Incision and Stromal Hydration of Corneal Incisions in Phacoemulsification

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ABSTRACT

Objective: To determine the efficacy of the Wong incision in providing wound seal compared to stromal wall hydration in clear cornea phacoemulsification in cadaveric porcine eyes.

Method: This was an in vitro comparative experimental study using ten porcine eyes. All eyes were randomly assigned to the stromal wall hydration (control) or the Wong incision group (experimental). A side port was made and the anterior chamber formed with viscoelastic device. The main incision was made 180 degrees away. In the experimental group, a Wong incision was made first anterior to the main incision. Phacoemulsification surgery with IOL insertion was simulated. The main incision was sealed by hydration. The anterior chamber (AC) was infused with balanced salt solution (BSS) through an AC maintainer and leakage of fluid from the main incision was assessed. Samples from the AC were taken before and after tryphan blue drip and were sent for analysis by UV spectrophotometry. Trypan blue was dripped over the main incision and the whole eyeball was sent for histopathology.

Results: There was a significant increase in density from the pre-dye to the post-dye AC samples of the control (0.0052 to 0.0074, p=0.01) and the experimental groups (0.0076 to 0.0094, p=0.02), although the final samples showed an optical density comparable to pure BSS, indicating that there was no significant amount of trypan blue detected in both groups. On histology, trypan blue staining was not seen in the incision tracts of both groups. After infusing the AC with BSS, there was outward wound leakage in all eyes of the control group and none in the experimental group.

Conclusion: The Wong incision was as effective as the lateral stromal wall hydration in preventing fluid influx. Furthermore, the Wong incision showed a more stable wound seal against outward wound leakage in an in-vitro porcine model of clear corneal phacoemulsification.

Keywords: Wong incision, supraincisional hydration pocket, stromal hydration, clear corneal incision, phacoemulsification, wound leak

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Cataract surgery has come a long way over the years. It is one of the most studied techniques, and has evolved from the large corneal incision of extracapsular cataract extraction to the use of scleral tunnel. Since its introduction in 1992, clear corneal incision (CCI) has taken the front seat in the drive towards minimally invasive ophthalmic surgeries, with its numerous advantages including shorter recovery time and decreased surgically-induced astigmatism.[1] However, as CCI is quickly becoming the gold standard in cataract surgery, there is also an increase in the incidence of postoperative infections such as endophthalmitis. Taban and colleagues[2] reported an upward trend in the incidence of endophthalmitis since 1992, increasing from 0.087% to 0.265% in the early 2000. This seemed to coincide with the same upward trend in CCI popularity. Wong TY and associates[3] showed that endophthalmitis occurred in 0.076% of cataract surgery patients in an Asian population, comparable to the rates found in Western countries.

The explanation for this upward trend in the rate of endophthalmitis may come from CCI wound construction and the postoperative forces that test its integrity. Intraocular pressure (IOP) varies widely, especially in the postoperative state. Shingleton et al[4] found that 21% of eyes following cataract surgery with CCI had a postoperative IOP of lower than 5 mmHg. This in turn may cause laxity of the wound structure, causing the internal and external lips of the incision to gape just enough to allow ocular surface fluid into the eye, and with it, bacteria.[4-6] Cham and coworkers[7] rated that the most common organisms in the normal ocular flora of Filipinos were coagulase-negative *Staphylococcus* and *Bacillus,* which were common etiologic organisms in postoperative infections. Dr. Murthy[8] reported that the frequently isolated *Staphylococcus* causing postoperative endophthalmitis actually came from the patient's own ocular surface flora, usually from the conjunctiva and eyelids.

Postoperative endophthalmitis, though rare, usually resulted in a final visual acuity of only 20/100 at 3 months.[9] Thus, phacoemulsification techniques have been modified to address this problem, paying particular attention to proper wound seal.

Cataract surgeons have used different techniques in securing good incision seal postoperatively, including suturing of CCI and stromal hydration. Wound suturing did provide a good incision seal as demonstrated by Taban[3] in cadaver eyes, but induced additional trauma and the suture tract could be a source of infection. Hydration of the lateral stromal wall of the CCI was subsequently developed, allowing less ocular surface fluid to enter the eye despite IOP fluctuations. The lateral walls of the incision were hydrated with an irrigating solution, either normal saline or balanced salt solution (BSS), through a small gauge cannula until stromal edema was induced. Wound seal was suggested by a dry external incision site after swabbing with a dry cellulose sponge. The stromal hydration caused apposition of the lips of the incision, thereby creating a relatively good seal as shown by Vasavada et al.[10] Some studies, however, showed postoperative wound leakage despite the stromal hydration of the incision site.[11] Dr. Wong[12] further described a technique of using a separate location for stromal hydration. The separate non-penetrating incision was performed superior and anterior to the intended CCI, providing a separate hydration site apart from the CCI itself (Figure 1).

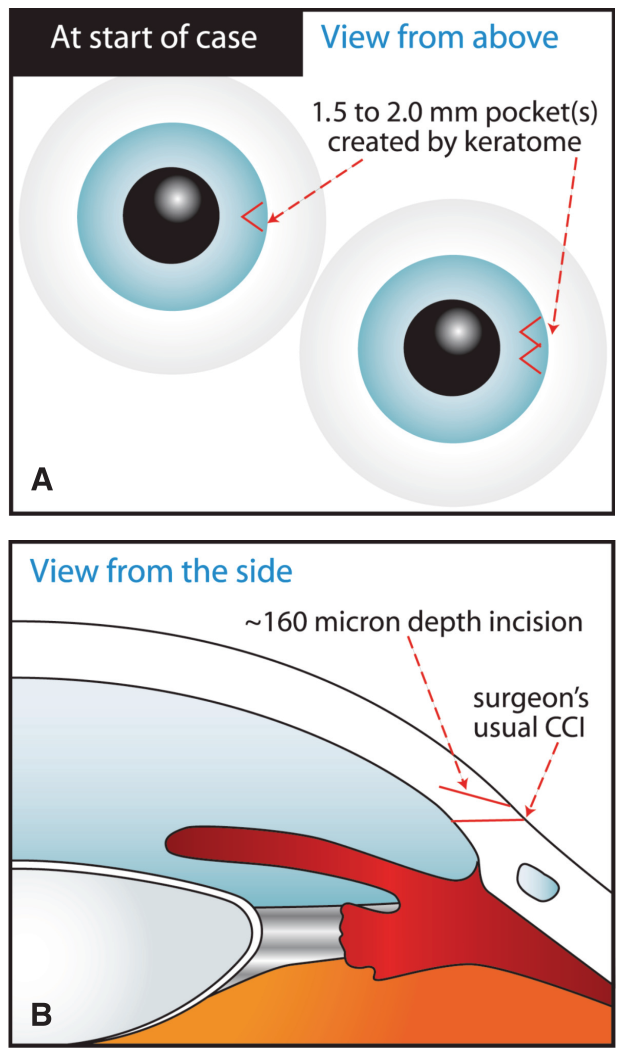

Figure 1. The Wong incision as viewed from above (A) and from the side (B) (Wong MY, MD).

This hydration pocket provided apposition of the entire incision tract for a longer period of time since it was farther away from the corneal endothelium where the pump mechanism to dehydrate the cornea resides, providing a more stable wound seal that could withstand postoperative IOP fluctuations.

The Wong incision is relatively easy to learn and perform but there are no studies demonstrating its effectiveness in creating a stable wound seal. Thus, we determined the efficacy of the Wong incision in sealing the CCI against influx of ocular surface fluid compared to the standard lateral stromal wall hydration using cadaveric porcine eyes.

METHODOLOGY

This was an in vitro comparative experimental study using porcine eyes. The protocol was reviewed and approved by the institutional review board of St. Luke's Medical Center. The porcine eyes were procured from a local wet food market and stored in an ice chest until use. All eyes were less than 12 hours post-mortem with clear corneas. Eyes with corneal pathologies, such as stromal haze and edema or evidence of previous trauma, were excluded. The eyes were randomly assigned to either the standard lateral stromal wall hydration (control) or the Wong incision (experimental).

At the start of the procedure, the globe was secured in a globe holder. A side port was created at the 3 o'clock position using a standard 15^0 metal blade (SatinSlit, Alcon Laboratories, USA). Viscoelastic (Aurovisc, Aurolab, India) was injected through the side port to deepen the anterior chamber. For the experimental group, a supraincisional hydration pocket (Wong incision) was made at the 9 o'clock position, approximately 1 mm from the limbus, using a 2.75 mm metal blade (SatinSlit, Alcon Laboratories, USA) (Figure 2). A standard two-plane CCI incision was made 0.5 mm posterior to the Wong incision. In the control group, only the standard two-plane CCI was made at the 9 o'clock position, about 0.5 mm away from the limbus (Figure 3).

Simulation of the standard phacoemulsification was done through the main incision using a phacomachine (Galaxy, Appasamy, India), with a bottle height of 120 cm and ultrasound power of 50% for 30 seconds. An intraocular lens (IOL) was implanted

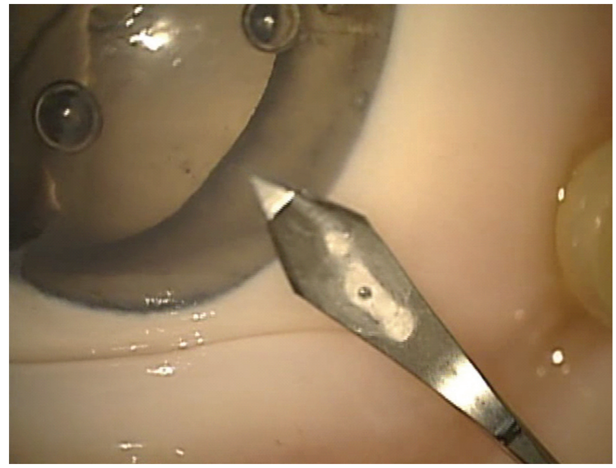

Figure 2. Creation of the Wong incision.

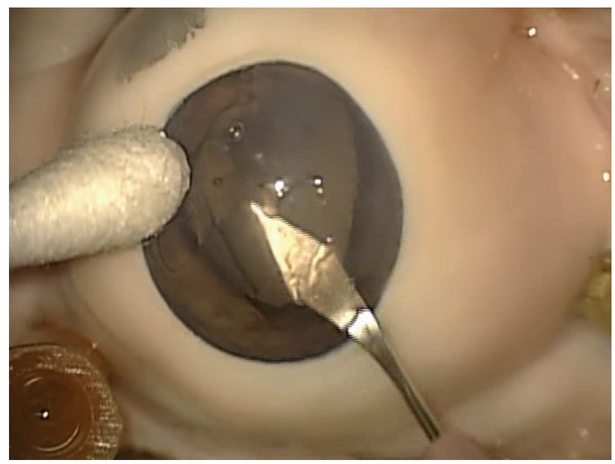

Figure 3. Creation of the main incision.

with the use of an IOL cartridge (Monarch C, Alcon Laboratories, USA). The main incision was sealed either by hydration with BSS (Alcon Laboratories, USA) of the lateral stromal wall (control) using a gauge 27 cannula or the Wong incision (experimental) (Figures 4 and 5, respectively).

Immediately after sealing the main incision, a standard gauge 21 anterior chamber (AC) maintainer (Hollywood Ophthalmic Supplies, India) was inserted into the side port and attached to a 1000 mL bag of BSS with full infusion at 120 cm bottle height until the AC was reformed. Wound leakage through the main incision was determined at this time; results were video recorded and tabulated. AC tap was done using a standard 1 cc syringe with a gauge 27 needle at the 4 o'clock position and a 0.2 mL AC sample was taken. This was marked as pre-dye sample and was sent for spectrophotometry. Once the AC was formed

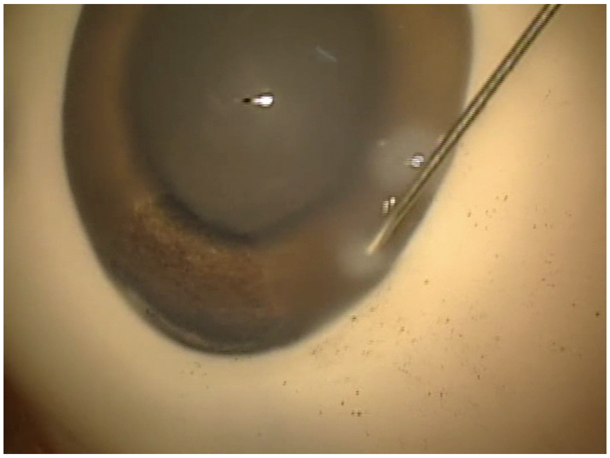

Figure 4. Hydration of the lateral stromal wall.

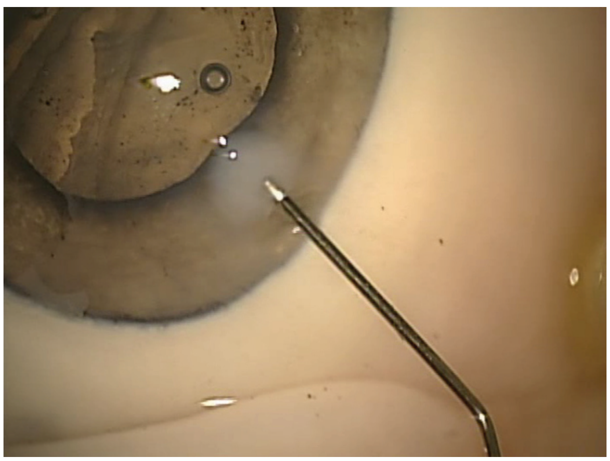

Figure 5. Hydration of the Wong incision.

and maintained, the infusion was closed. Trypan blue dye (0.06%, Aurolab, India) was continuously dripped over the main incision, taking care not to contaminate the 3 and 4 o'clock areas. A 1 cc syringe with a gauge 27 needle was used to aspirate another AC sample from the 4 o'clock location, this time taking enough AC fluid until iridocorneal touch was noted. This aspirate was marked post-dye sample and was sent for spectrophotometry. After which, the whole eyeball was placed in a sterile specimen cup and fixed in 10% formalin solution for 2 days before histologic examination and photography.

Histologic examination of the main incision tract was done by the pathology laboratory of the hospital. The tract was examined and photographed to assess the presence of trypan blue.

The amount of trypan blue was estimated from the anterior chamber samples by measuring its optical density with a UV-visible spectrophotometer (ND-1000, NanoDrop, USA). A standard curve was created at 595 nm, which is the maximum absorbance of undiluted trypan blue, as previously determined[8]. The absorbance levels of undiluted trypan blue and serially diluted trypan blue up to a 1:1000 dilution were taken. Absorbance levels at 595 nm of each of the pre-dye and post-dye AC samples were determined. The values were compared to the standard curve and were sent for statistical analysis.

Outcome measures included the presence or absence of trypan blue particles in the main incision tract, as seen by light microscopy. Increase in the light absorbance as determined by spectrophotometry of the trypan blue tracer from the pre-dye to the post-dye AC aspirates were obtained. The increase would indicate an increase in sample density which may be due to the trypan blue or other solutes. This was measured according to their absorbance levels as compared to those of the different dilutions of trypan blue (from the standard curve). Another measure was the difference between the light absorbance of the post-dye samples from the control and experimental groups.

Documentation of wound leakage after sealing the main incision and after the introduction of the AC maintainer was acquired on video. Any sign of fluid leakage through the main incision was measured as positive.

Data were tabulated and organized into separate groups for analysis via Microsoft Excel. Statistical analysis was done using an online statistics program. To measure an increase in the absorbance levels from the pre-dye to the post-dye samples within the different groups, a one-tailed paired t test was done. To measure any significant difference in the absorbance levels of the post-dye samples between the two groups, a two-tailed unpaired t test was done. In all analyses, a p value of less than 0.05 was considered significant.

RESULTS

A total of 10 porcine eyes were used. Half were randomly assigned to the stromal wall hydration (control) and the other half to the Wong incision (experimental). All eyes were used within 2 days after procurement.

Histology

Histologic sections of the main incision tract for the control and experimental groups showed no sign of trypan blue staining on any part of the tract (Figures 6 and 7).

Table 1. Spectrophotometric absorbance levels of pure and serially diluted trypan blue and pure BSS.

Trypan blue concentration (Dilution factor)	Absorbance levels (at 595 nm)
100% (pure trypan blue)	0.205
50%	0.107
25%	0.464
12.5%	0.879
6.25%	0.640
3.125%	0.363
1.56%	0.191
0.78%	0.106
0.39%	0.058
0.195%	0.031
0.1%	0.019
Pure BSS	0.012

Table 2. Spectrophotometric absorbance levels of AC samples.

Hydration type	Sample	Pre-dye AC sample	Post-dye AC sample
Stromal wall hydration	1	0.004	0.007
	2	0.006	0.010
	3	0.005	0.005
	4	0.004	0.006
	5	0.007	0.009
Wong incision	1	0.006	0.010
	2	0.007	0.008
	3	0.008	0.009
	4	0.008	0.010
	5	0.009	0.010

Table 3. Absorbance level of the control and experimental groups.

	Absorbance levels (mean ± SD)		
	Pre-dye AC sample	Post-dye AC sample	p value
Stromal wall hydration	0.0052 ± 0.0013	0.0074 ± 0.00207	0.01
Wong incision	0.0076 ± 0.00114	0.0094 ± 0.00089	0.02

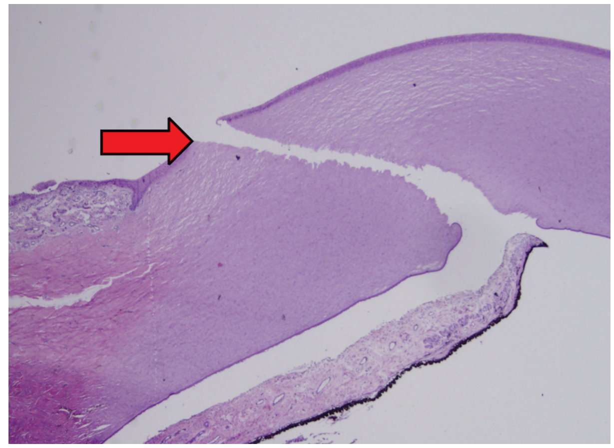

Figure 6. Histologic photomicrograph of the main incision (red arrow) of the control group with stromal wall hydration. (Hematoxylin-eosin stain, original magnification x4).

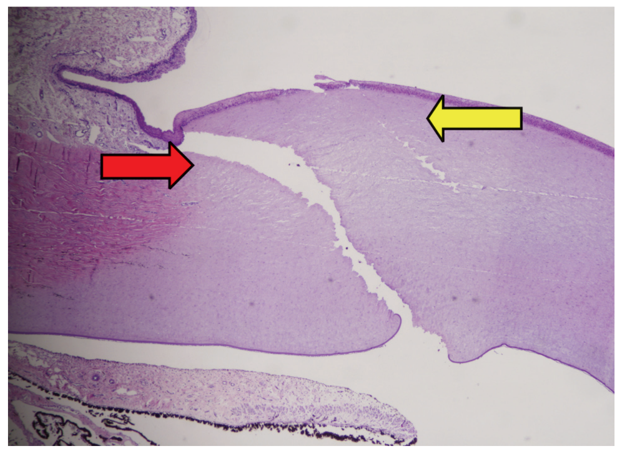

Figure 7. Histologic photomicrograph of the main incision (red arrow) of the experimental group with the Wong incision (yellow arrow) located anteriorly (Hematoxylin-eosin stain, original magnification x4).

UV Spectrophotometry

Table 1 summarized the spectrophotometric absorbance levels of trypan blue, from a pure sample to serially diluted samples of up to 1:1000, including the absorbance level of pure BSS which was used to dilute the dye. Table 2 showed the absorbance levels of the pre-dye and post-dye AC samples. The mean absorbance level for the control group was 0.0052 pre-dye and 0.0074 post-dye. The mean absorbance level for the experimental group was 0.0076 pre-dye and 0.0094 post-dye. In both groups, there was a significant increase in density from the pre-dye to the post-dye samples (Table 3). There was, however, no difference between the post-dye samples of the control and experimental groups (p=0.08). These post-dye values were less than the absorbance level of pure BSS.

Video Documentation of Wound Leakage

Figures 8 and 9 showed the video captures of the main incision of the control and experimental groups, respectively during placement of the AC maintainer attached to a 1000 mL bag of BSS at 120 cm bottle height and at full flow. In all eyes of the control group, fluid leakage was present. In contrast, no leakage was seen in all eyes of the experimental group.

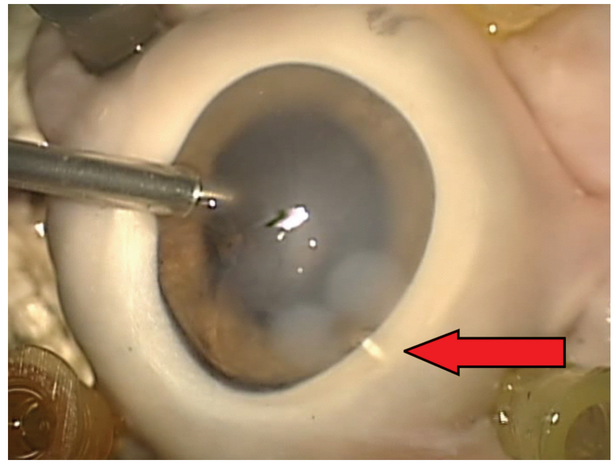

Figure 8. Video capture of the control group after stromal wall hydration of the main incision. Note the fluid leakage (red arrow) upon placement of the AC maintainer.

DISCUSSION

The results of the spectrophotometry showed that there was a statistically significant increase in the absorbance levels between the pre-dye and post-dye AC samples of both the control and experimental groups. Although this might lead one to think that trypan blue was present in the AC, the final absorbance levels, however, were still comparable to that of pure BSS. This meant that no detectable amount of trypan blue dye was able to enter the anterior chamber even after the maximal vacuum was reached during the second AC sampling and dripping of trypan blue over the main incision. This was explained by the excellent sealing ability of both techniques of hydration against severe ocular hypotony. It has been postulated that the fluctuating IOP postoperatively may create a vacuum that could potentially aspirate extraocular fluid into the eye. As shown in this and previous studies,[10] stromal wall hydration and the Wong incision were both effective in preventing extraocular fluid influx even in the presence of an intraocular vacuum. The increase in the absorbance levels in the post-dye samples may be explained by other factors, such as the presence of iris pigments, lens, or other materials that may have been aspirated in the second sample.

Histopathology showed no trace of trypan blue in all incision tracts. This result correlated with the spectrophotometric findings. It showed that the Wong incision was as effective as the standard stromal wall hydration technique in preventing fluid ingress into the wound in spite of an intraocular vacuum.

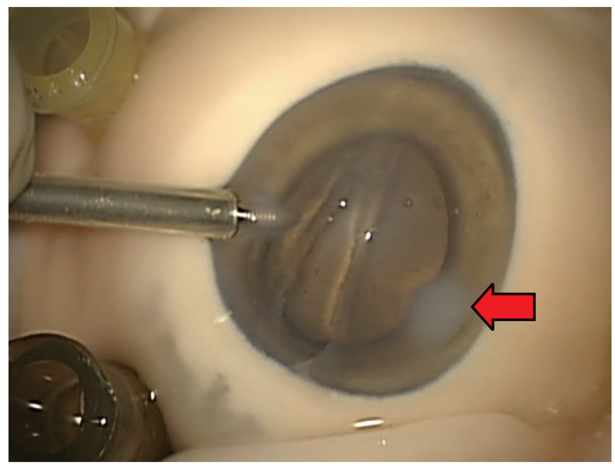

Figure 9. Video capture of the experimental group after hydration of the Wong incision (red arrow) and placement of the AC maintainer. No evidence of wound leakage was noted.

During the simulated surgery, it was shown in the video that when the AC maintainer was introduced through the side port, with a bottle height of 120 cm and at maximal flow, BSS quickly flowed out of the middle portion of the main incision of the control group. In stromal wall hydration, only the lateral aspect of the wound was hydrated, leaving the central portion less coaptated. The wound leak decreased when the bottle height was lowered to 30 cm and the leak eventually stopped when the influx of BSS was discontinued. In the Wong group, there was no leakage at all bottle heights and at maximal flow. All parts of the incision were sealed. When the Wong incision, a separate pocket created anterior to the main incision, was hydrated, it effectively sealed not only the lateral aspects of the wound but also the central portion as well. The hydrated pocket created a downward pressure over the entire tract, thereby creating maximal seal and virtually no wound leakage even in the face of increased intraocular pressure.

This in-vitro porcine study proved in principle that the Wong incision was as effective as the standard lateral stromal wall hydration in preventing extraocular fluid influx even in the face of an intraocular vacuum. The results showed no detectable influx of trypan blue within the incision tract or in the AC fluid aspirate. One distinct advantage of this new technique was that the Wong incision was more effective in preventing wound leakage in the presence of high intraocular pressure.

The main limitation of this study was its in-vitro animal model design. Findings of this study simply provided proof to a principle and should not be totally extrapolated to actual human phacoemulsification surgeries. The authors recommend doing further study using fresh human cadaveric eyes.

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