Newer and More Effective Techniques in Phacoemulsification

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Advances in the field of cataract surgery and intraocular implantation over the last fifty years have been astonishing. Phacoemulsification, had a slow beginning, but in the last 5 years has exploded forwards. Improvements in technique are increasing at a rapid pace as the advantages of small incision cataract surgery, the instant patient rehabilitation physical and visual is obvious. Nevertheless, the ultimate expression of minimal patient inconvenience and minimal delay in resumption of patient lifestyle is the legacy of phacoemulsification.

It was in the winter of 1989 when I performed my first cataract operation utilizing phacoemulsification. From that moment, I had no doubts that this was a winning combination and in future all cataract operations would be performed with this technique and with this technique only. The procedure has changed since then. It has evolved and improved significantly. The technique has been perfected. The machine technology has progressed. The quality of the surgery is now virtually unsurpassable, and most importantly, surgeons all over the world now trust and rely on the phacoemulsification technique.

Old concepts change, giving way to new ideas, as fresh advances in all fields of science and medicine forge ahead. Phacoemulsification surgery is no exception. The visual needs of patients are dictated by their circumstances which include age, occupation, leisure interests, and their independence. As an adviser to a patient, the ophthalmic surgeon must consider the individual requirements of the patient and balance these against the potential risks of surgical treatment. As a surgeon, his attitude is tempered by his experience, knowledge of the experiences of others and confidence in his own ability to achieve perfection of results that should shine as a beacon of excellence in the community.

Every step of phacoemulsification procedure is critical in determining the final surgical outcome. The surgery is a sequence of steps each, fundamentally important to the entire procedure.

Newer advances in phaco have occurred over a period of time. However the main developments which have fueled a rapid development, in my opinion, are:

a) Instrumentation. Development of the third generation phaco machines with surge control, better "drive" capability, and stable fluidics.
b) Newer phaco tips, better cooled, better fluid ventilated, better cutting, better tuning.
c) Newer phaco techniques enabling any density of lens to be chopped in minimal time, with equal safety.
d) Better foldable lOLs, better results

Today, I am going to discuss three new developments in phacoemulsification, which I have personally pioneered and which I believe will go a long way in making Phacoemulsification better and more effective.

Vertical "Hubbing" Phacoemulsification Phacoemulsification Technique

There are two methods which I use. The first is the Tangential Phaco chopping technique a method which was popularized in 1996 (Mehta). The second which I prefer is the Vertical nuclear 'hubbing' Phacoemulsification.

In 1996 I developed the tangential chopping technique whereby the chop rather than going vertically through the substance of the lens, would go obliquely. One had merely to tip an edge of the nucleus out, impact the nucleus in the middle with a phaco tip and using a sharp edged but blunt tipped chopper obliquely the lens is plot from the periphery to the center. The advantage was that rather then trying to split the lens vertically literally "shards" of the lens were removed. The lens was rotated and then chopped again, once again obliquely. Ultimately only the thin central shard was remaining which could be flipped out and phaco'd. It proved very effective especially in hard cataracts. The big advantage was that the capsule was never at risk.

In 1998,1 conceived of the concept of Vertical Phacoemulsification whereby the nucleus was tilted vertically. Considering that the maximum density of the nucleus is on the middle, common sense dictated that if one could remove the hard central core, one would literally convert the entire nucleus into a simple doughnut. The peripheral ring composed off much softer nucleus and epinucleus would come out easily.

I therefore designed the system of "Hubbing" Phacoemulsification, where the nucleus could be "hubbed" or removed by coring out the middle of the lens.

Technique Of Vertical "Hubbing" Phacoemulsification

It is a very simple technique. So simple in fact that when I demonstrate it to visitors in my theatre, the first comment usually is "Looks easy why has no one thought of it ?"

The technique involves a 6.00 mm rhexis, following a full hydrodissection placing the nucleus vertical viscodissection at the 9.00 o'clock position with the nucleus at 3.00 o'clock position standing out of the capsule bag (Lens salute).

The steps of the surgery are as follows:

Nuclear stabilization: Viscoelastic is injected from the side port incision. This manages to stabilize the nucleus and prevent it from flopping back. From the side port, enter with the blunt tipped, but sharp sided chopper and support the nucleus.

Coring the Nucleus: The next step is to core out the center of the lens. In this technique termed "hubbing", I like to use the Kelman bent 0.9 dia phaco tip as it penetrates easily in the nuclear matter. The phaco settings are now altered to 70% phaco power, vacuum is reduced to the minimum. Thus when energized, the phaco tip can penetrate, and move out of the nucleus without displacing it since no suction is involved.

Supporting the nucleus from the left with the phaco chopper held flat against the nuclear surface to stabilize it, the phaco tip is placed squarely in the middle of the lens and literally allowed to penetrate virtually all the way through. The first core, made in the middle of the nucleus is called the primary core. Subsequently make three, one secondary core just above, and two, one at each side of the primary core. The next step is to rotate the nucleus by 90° and make the final core. In any lens up to Grade 4 in density, a total of five cores (one central primary and four secondary cores) will literally, eliminate the hard central nuclear matter. If it is harder cataract, another set of four cores (termed tertiary cores) are placed a little peripherally and in-between the previous four secondary cores.

Snapping the periphery: The lens is now converted into a doughnut. To aspirate the final rim, it needs to be snapped. The chopper, which till the present was only supporting the nucleus for the coring is now allowed to slip in-between the cored nucleus. Using a phaco in the right hand, the ring is split open using the sharp inner curve of the chopper. After snapping the ring, it is slightly widened.

Pulse aspiration of the ring: The open end of the doughnut ring is allowed to impact onto the phaco tip. The settings now change. Ultrasound power is kept at 20-30% depending in the density of the lens, set Pulse at 8 pulses per second. Vacuum is set at 400 mmHg, Flow rate at 18 ml/min, energizing the tip will lead the entire rim of the lens to rotate (carrousel) till it is fully removed.

An average phacoemulsification, from beginning to end, done with no haste, in a medium dense Grade 4 cataract, with this technique can be completed easily in 6 minutes.

Indications

Though it is an exceptional technique and can be used in virtually any type of density of nucleus, it however does require a little care. It is difficult to tumble the lens through a rhexis smaller than 6.00 mm in size. It is possible to enlarge the rhexis using the split rotation technique described elsewhere. Since the quantum of ultrasound energy liberated in the anterior chamber is very low, it can be used safely in Fuchs dystrophy, patients with a low endothelial cell count, or prior keratoplasty, where the regular options do not apply.

The important question, often asked is whether doing a regular phacoemulsification as compared to a vertical phacoemulsification shows any disparity in endothelial cell loss. It is often thought that since, in coring U/S energy is used more, the endothelial cells may be affected, But in fact the extra energy is masked off the cells by the fact that a phaco needle buried in the substance of a lens does not radiate any energy out. A Topcon endothelial specular non-contact microscope coupled with its own special "ImageNet" software, showed no cell loss of any significance in a series of 125 consecutive cases. Though, in theory, endothelial cell changes must occur in any surgery, in practice there is hardly a +/- 3.00 % variation change in the endothelial cell count.

Perhaps the greatest application of this technique is that it is an exceptional transition technique for teaching residents, fellows and young pledging surgeons the art of phacoemulsification without inducing any complications. It is easy to do, minimizes the risks of capsular damage, removes the chances of inadvertent iris contact, and enables even a hard cataracts be done with safety in a short period of time. It is thus the technique of choice in Eye Camps where, I am sure, it will supplant the regular technique in time.

Multiport Phaco "Trainer" Tip

A safer and more effective teaching device for phacoemulsification

Phacoemulsification is a superb technique and is now a well-recognised procedure. However like all good surgical techniques, despite theoretical teaching and subsequently practical instruction on animal eyes, the finer points can only be taught, hands-on, on patients.

Phacoemulsification also has its complications if inappropriately done; the problem has always been how to teach phacoemulsification without leaving complications. Even in the best hospitals in the world, the teaching curve of residents will always leave behind a trail of broken capsules and even an occasional dropped nucleus.

A decade ago, when phacoemulsification was still rising out of the dark ages at most major meetings, worldwide, the teaching curve of this procedure was always alluded to as overly extended. A popular saying was "The road to phacoemulsification is slippery with vitreous" and "Dropped nuclei are the milestones in the path of phacoemulsification".

Fortunately, these days have long gone. Still complications do occur. Any new technique that could reduce this problem is always useful.

To obviate the major risk in phacoemulsification, namely the broken capsule and its following train of complications, a multiport phaco tip has been designed which would seem to work very well. However to really appreciate how this tip works one needs to know a little more about the functions and the drawbacks of the phaco tip.

The Functions of a Phaco Tip

The phacoemulsification hand-piece generates ultrasound energy, which it uses for cutting and emulsifying power, while at the same time providing irrigation and aspiration.

The phaco tip has three major functions:

1. The primary function of the phaco tip is to convey the generated ultrasound energy to the nucleus, to be used for cutting and emulsification of the nucleus.
2. The secondary function, which is very important, is to hold and stabilize the nucleus for phaco maneuvers and to act as an additional pivot and fulcrum point. It is this secondary function, which is so vital for good phacoemulsification.
3. The tertiary function is to provide a pathway for the outflow of irrigating solution, nucleus fragments, cortical remnants and other debris, while at the same time permitting an irrigation inflow via the silicone sleeve that sheaths the tip. It also prevents turbulence and cavitations via the newer phaco tips and silicone sleeves.

BASIC PROBLEMS WITH A PHACO TIP

The present day phaco tips, for all their sophistication have two major problems.

1. Inadvertent capsular contact

Can occur fairly easily as the tip is the part, which is closest to the capsule, and since the entire aspiration of cortical and nuclear debris is limited to the tip only.

Present day requirements of high suction to hold the nucleus for chopping obviate the safety measure of keeping far away from the capsule, as the tip has to penetrate deep in the nucleus to hold it. The possibilities of surge when the tip suddenly releases hold may lead to inadvertent capsule break, with catastrophic results.

2. Blockage of the bore of the tip

Naturally any device that uses vacuum to suck up bits and particles is liable to get blocked some time or other. The ultrasound phaco tip normally does not get blocked because the ultrasound energy clears the throat of the tip and keeps it open. However when handling hard cataracts or using inadequate ultrasound energy, the tip may get blocked.

There are two problems with the blockage of the tip, which need to be considered in detail.

(a) Sudden collapse of the anterior chamber due to surge

Surge is the development of sudden high suction that develops when a blocked tip suddenly opens up.

There are various devices designed to eliminate or control surge.

a) **Enhanced irrigation input.The** simplest way is to have the third port, i.e. a third line at the 6.00 o'clock position through a side tube (Blumenthal) attached to a drip stand. The moment suction breaks, an increased quantum of inflow via the side port will stabilize the chamber and control the surge. Another simple way is to increase the inflow via the irrigation line by having a double drip stand connected with stiff, wide-bore TUR tubing. (Mehta 1997). (Urogenital surgeons use it for prostatic Trans Urethral Resection). This wide bore tube commercially available, sterile disposable tubing enhances the flow when a sudden break occurs. A similar system using conjoint tubing has also been described as the Bangkok system. The Ocusystem II"[1]^ utilizes the double bottle setup for the surge prevention fluid venting system.

b) **Usage of a computerized pump slowdown.** The newer computerized units like the Alcon Legacy the Allergan Prestige and Soverign and the Storz Millennium, use a computer controlled program to control surge safely. Surge is the development of sudden high suction that develops when a blocked tip suddenly opens up. The moment the vacuum breaks at the tip end, to prevent surge development, the computer immediately slows down the peristaltic pump (Alcon 8;. Allergan), or the rotor (Storz) for a few seconds, which compensates perfectly, virtually eliminating chamber variations or collapse. It is this 'fluidic control' that makes all the difference in a dangerous situation.

c) **The use of diaphragm drum.** The Opticon Pulsar and the Mentor SIS system use a diaphragm drum. The sudden development of surge is partially damped down by the diaphragmatic membrane movement. Surgin Co in USA, has also taken out small flexible round thin walled collapsible plastic loop, which can be fitted at the end of the phaco handpiece and which would compensate for any sudden variations. This unit works with any instrument.

(b) Corneal/Scleral burns

The phacoemulsification tip remains cool by the irrigation inflow passing over the surface of the phaco tip conducted via the silicone sleeve, and partially, by the continuous outflow of the aspirate fluid (with nuclear, cortical and capsular debris).

The silicone sleeve goes through the corneal opening and is likely to get occasionally kinked or even compressed if the opening is not exact and perfect. When the flow of the irrigation is slowed down or stopped, and ultrasound energy is turned on, corneal/sclera burns due to the overheated phaco tip, can easily occur. The sclera is a little resistant to burns but the cornea, unfortunately is not. Once the burn in the cornea occurs, the cornea remains open like a cantilevered bridge and will not seal necessitating a suture at the end of surgery and subsequently inducing astigmatism.

Where Lies the Answer to these Problems?

Preventing burns is fairly easy by modifying the tip as has been done by the Storz Microseal handpiece which utilizes a dual infusion sleeve, the inner rigid sleeve is between the silicone sleeve and the ultrasound titanium tip. The OcusystemII"'* uses rigid clear polysulphone sleeves, which negate chances of a corneal burn. The Surgin tip has a dual ply mesh material in the sleeve that prevents occlusion and is virtually impossible to pinch off the flow and produce a burn.

The problem of surge control is, however a different matter. The obvious answer is to modify the phaco tip to obviate the problem of a pure tip - based suction and aspiration of the emulsified debris. If the tip can be altered so that it maintains the ability to hold and cut, while minimizing sudden surge, then the risk of capsular break can be significantly reduced, if not eliminated.

The Multiport Phaco Tip - Its Design

The salient features are two side ports 0.50 mm behind the apex of the 15° phaco tip. The side ports, each with a width of 0.3 mm are beveled inwards, at 30° angle, to prevent any capsular catch. The phaco tip is also beveled inwards, which improves its cutting and holding ability.

How does the New Multiport Phaco Tip Function?

1. The suction, at the tip, which though required for the aspiration of the emulsified matter, is responsible for the capsular damage in phaco. The suction is now divided between the tip and the side ports. The area of the side port almost equals the area of the tip; hence tip suction is markedly minimized. The capsular hold can only take place when all the three ports are occluded simultaneously.

2. The side ports are only 0.5 mm away from the tip. Thus when it is required to hold a nucleus to chop it or to maneuver it, one needs to only bury the tip beyond the side ports, i.e. 0.8 mm. This entry of less than a millimeter is more than adequate to occlude all the three ports thus generating suction for holding the nucleus in a manner similar to a standard single port tip.
3. Since there are three ports, and since most blockages of the phaco tip only occur at the tip, surge is very unlikely to develop, with its risks of chamber collapse and capsular tears.

4. The presence of the three ports diminishes the tip suction, but at the same time gives three ports for the aspiration, thus cleaning the peripheral cortex simultaneously. As a matter of fact with this divided suction, if the phaco suction is turned down to 60 mm vacuum, one can almost use it as an irrigation/aspiration device. At this pressure rating the tip can be moved over the capsule without occluding and breaking it.

5. The novice, or, for that matter, even the seasoned practitioner, when he accidentally goes through a nucleus, is likely to break the posterior capsule, almost immediately. The advantages of using this tip as a "trainer" tip for newcomers to phaco thus become obvious. Training residents becomes far easier. Rather than restricting the student to only specific phaco techniques, he can practise all the techniques with a reasonable modicum of safety. The Multiport phaco tip thus functions like a safety net, and most important of all, the patient does not have to suffer for the student's error.

Advantages of the New Multi-Port Phaco Tip

The new multiport phaco tip works like a regular 15° phaco tip. It holds the nucleus identically to a regular tip, permitting stop and chop, phaco chop, tangential chop and any variant of these techniques. It aspirates the emulsified debris much faster than the normal, unventilated phaco tip. Even deliberate touch on the capsule, with the ultrasound on, does not break the capsule. Therefore there is a significantly enhanced safety with the chop procedure with no risk of capsular break in sudden fluid pressure imbalances. It is thus ideal for the novice, and even the, occasionally distracted, experienced, phaco surgeon. It is possible to remove the nuclear girdle very easily and even a fair quantum of cortical debris.

The Multiport Phaco Tip - A New Teaching Tool

The greatest problem with phaco is the inordinate complications with accelerated teaching methods. The commonest point of rupture of the posterior capsule is during grooving, especially the deeper part of the nucleus, or when entering the nucleus to hold it for chop procedures.

A novice, rather than making a single ultrasound burst to penetrate and thus hold the nucleus preparatory to chopping it, makes a timid entry which only makes a small hole, inadequate to hold the nucleus. He then makes another timid entry, again inadequate, but which makes the hole in the nucleus deeper and broader. Despairing, he gets bold, enters via the same small hole, turns on the U/S and promptly goes through the nucleus itself. With this tip, even if he goes through the nucleus, provided he had hydrodissected it well, there is no risk of capsular damage.

The Multiport phaco tip permits all the standard phaco manoeuvres like, rotating the nucleus with the phaco tip in the eye, flipping a lens over in the penultimate phaco flip, perfectly safe, provided the student exercises a modicum of care and restraint.

The Latent Problems When One Have to Teach a Student or a Novice the Art of Phacoemulsification

The tutor has to first demonstrate the surgery to the student, make sure he knows the concepts well, and has seen enough phaco surgery on a video to at least know the facts and how to manage a problem if it occurs. He should also have spent time with the actual machine on pig's or goat's eye so that before he touches human eye he is as well trained as is possible.

The tutor then has to, literally, handhold the pupil till his natural, sometimes deeply latent, abilities take over. It is a fact that no matter how many cases are seen prior to learning phaco, there is no substitute to actual practice. The only way to teach phaco is with the phaco handpiece in the student's hand. No matter how good the tutor, and no matter how careful he is, complications will occur. The question is to anticipate them and to minimize them.

The new Multiport Phaco Tip is thus a Godsend, and will minimize complications very significantly. Any procedure, which can assist easier learning, which is safe for the patient, will make a world of difference. Thus this Multiport Phaco tip which has inherent safety features is very important, not only from the learner's and tutor's view points, but most important from the patients. The only disadvantage, if it can be called that, is that it slows down the phacoemulsification procedure a bit, which is an advantage as far as the learner is concerned.

How does this Tip Differ from Other Multiport Tips?

Alcon for its Legacy Unit, makes a tip with an opening almost 14mm back from the tip, with the idea that when the tip obstructs, rather than the full suction being applied to the tip, part of the vacuum is diluted by by-passing the blocked tip via the fine 0.1 mm opening. A good concept, a wrong application. It has no function, as the surge is already compensated by the superb fluidics of the Alcon Legacy and by itself the tip is useless to use as a trainer tip.

My original paper on the multiport tip had been presented at the All India Ophthalmological Society conference in January 1997, a little more than 3 years ago. At that time I had thought it was a good idea to cut down on accidental capsular breaks, but had not considered it as a "Trainer" Phaco tip till I discovered the benefits almost a year down the line. A few months later another paper had been presented at the ESCRS meeting, by a French author, along the same lines. This tip, had a single port almost 3.5mm away from the tip and on the upper surface of the tip termed as a 'magic hole'. This modification again does not in any way work as a Trainer tip.

Availability of the Phaco "Trainer" Tips

The Phaco Trainer Tips can be made on any tip, for any emulsifier. At present it works on both the authors Opticon Pulsar as well as the Alcon Legacy. The tips at present are being ground by "Ingenious Medical Devices" in India. You need to send your phaco tips, which are modified and shipped, back to you, but they can be made by any competent workshop anywhere in the world. Though the author has patented the Multiport Phaco tip, anyone is free to make and use the tip.

In Summary

Phaco is, undoubtedly the cataract surgery of the new millennium. Surgeons as well as patients demand it. Even the rural patients have tasted its benefit and ask for it by name, and literally, clamor for it. The results once experienced are difficult to equal by any other method. This new phaco tip seems to be the answer to most of the vexing problems of training a legion of new surgeons, the art of phacoemulsification. The new tip has made this already superb procedure, better, highly predictable, and most important of all, safe. The important factor of the learning curve with its attendant problems can be offset by the use of this simple, yet beautifully functional, and efficient multiport trainer phaco tip.

Endothelial Cell Protection Techniques in Phacoemulsification

a) Decrease fluid input coupled with zero suction

It is a well-established fact that prolonged irrigation; coupled with excess aspiration, tend to lead to cell loss. It can be minimized by (i) altering the irrigation solution used (BSS Plus is the most innocuous) (ii) Usage of zero suction by disconnecting the suction line from the machine. However, zero suction is a problem with the new techniques of chop, which require a firm, hold on the cortical nucleus to be able to chop it successfully. Present day phaco, unless it is being performed on a very hard cataract usually is a short procedure and hence the fluid exchange in the chamber is rarely more than 150 ml.

b) Viscoelastic protection

The use of dispersive viscoelastics is supposed to significantly diminish the propensity towards endothelial cell loss. (e.g. Viscoat). It must however be clearly understood that the primary aim of viscoelastic substances (VES for short) is that they are space occupying, and maintain the chamber.

Steve Arshinoff, divided viscoelastic substances into two basic groups. An understanding of these groups goes a long way in appreciation of their protection abilities. He divided viscoelastic substances into:-

a) High viscosity and cohesive ability with zero shear rate and possessing a high molecular weight (examples are Healon, Healon GV, Proviso, Amvisc and Biolon).

b) Lower viscosity with low cohesive ability but with exceptional dispersive ability, possessing a low molecular weight (examples are Viscoat, Vitrax, HPMC).

The high cohesive viscoelastic substances with high viscosity are very useful for the creation and maintenance of space in the anterior chamber. In addition they enable stabilization of the nucleus and the torn capsule during the capsulorhexis procedure. They can also be used as a tool to separate and dissect tissue like re-opening adhesions or reforming a flat chamber. They also act as a inertial energy control when the IOL is shot out of an injector and the viscoelastic substances damps down the speed of silicone unfolding, preventing damage to the tissues. In addition they act as a tamponade for the vitreous in the unlikely event of a capsular rupture.

The high cohesive viscoelastic substances have the advantage that they are very easy to remove during the final irrigation/aspiration phase.

The high dispersive viscoelastic substances have the advantage that they break down (or disperse) into their components (hence the term dispersive). This group of products forms an adherent layer, which clings onto the endothelium, literally acting as a second skin, and protects the endothelium from the effect of deleterious substances. It is this group which is very useful in performing phacoemulsification on eyes with a poor endothelial cell count. It also has the advantage that it traps the nuclear fragments, preventing them from bouncing off the endothelium during phacoemulsification.

The dispersive viscoelastic substances have the disadvantage that at the end of the procedure, they have to be literally, vacuum aspirated.

A combination of these substances is now available - Amvisc Plus (Bausch & Lomb). It is said to combine the advantages of both, and is moderately cohesive as well as dispersive.

a) Use of freezing solutions

Both the viscoelastic as well as the infusion solutions, if used ice-cold are said have a preservative action on the endothelium: Edelhauser 1998. In addition the use of freezing solutions also minimizes the incidence of corneal burns from the phaco tips, especially when high ultrasound energies are used with the very hard (suprahard) cataracts.

b) Pulse Phaco usage

Diminishing the phaco power by using the pulsed phaco method, and a more sensitive control with better tuning capabilities have both helped to diminish the cell loss. The only problem with pulsed phaco is that it is difficult to really get a good hold on the lens for chopping and thus can only be used after the primary phaco procedure of nuclear chopping is over. A modified version of pulse mode is the Burst mode (the AMO Diplomax and the Alcon Legacy), which, in essence, gives a fixed series of pulses and stops so that the lens can be held. It, however, has the problem that if attempted, just a bit carelessly, the burst will, in a medium cataract, go all the way through, promptly rupturing the capsule.

c) Proper tip placement

Though newer techniques like tangential /vertical chop have helped further, by decreasing operative time and diminishing intracameral acrobatics, the modern techniques of phacoemulsification depend much more on the ability to properly position the tip to be in an optimal position to hold a lens and chop it down into smaller parts, permitting easy emulsification using negligible ultrasound energy. The problem only comes about if the cataract is very hard. Now the number of times the lens has to be held with bursts of ultrasound power increases. Since the fragments are very hard, the energy required to engulf and emulsify them also increases. Naturally the endothelium exposure to U/S energy will increase.

The Advent of the Concept of Physical Endothelial Cell Protection

The obvious answer is to protect the endothelium from the deleterious effects of ultrasound, the turbulence of the irrigation fluid, the noxious effects of the irrigating solution and/or intracameral injections (like Xylocard) on the cornea and the accidental touch with the endothelium during intracameral maneuvers. The barrier should be for functional reasons, a physical barrier.

The obvious solution in providing a physical protection for the endothelium is the "Hema Hood". Here a Hema membrane is used to protect the endothelium of the cornea by placing it in direct contact with the endothelium. Thus, in essence, it functions as an endo-corneal contact lens. The method devised acts as a physical barrier literally like a corneal endothelial umbrella.

Hema Intracameral Endothelial Contact Lens

The Hema material used in the Hood has also been used by the author for fashioning Hema soft IOL from 1977 onwards and has been in usage for over 18 years, first as an Iris Clip lens and later as a Disc P/C. It is a proven concept that a soft IOL touching the endothelium of the cornea lead to virtually no deleterious effect. Packer 1978, Mehta 1997,98

The Design of the Hema Hood

The Hema Hood is designed with a front surface curve of 8.20 mm, of Piano power, 9.00 mm total diameter. The central thickness is 0.18 mm. The edge is made with a reverse bevel, which prevents the Hood from being dislodged by a stream of BSS from the phaco needle.

The Material of the Hema Hood

Wohik (German) soft contact lens material
Hexa methyl meth-acrylate with cross polymers and EGDA

Refractive Index	1.44
Elasticity at break	1.40
Oxygen permeability	4.43*10 -9
Hydration:	
Saline content	38.8 %
Water uptake	62.3 %
Saline uptake	63.6 %
Temperature resistance	No change in parameters after boiling for 24 hours
Light Transmission	400-800nM

Ash Content.0.1 mg in 3.00 gm ashed

The Surgical Technique of Using the Hema Hood

Preparation of the Hood for usage

The endothelial Hood is presented in a metal foil sealed bottle filled with BSS, sterilized by autoclaving, and sealed in a sterile, (ETO gas) double pouch. The surgeon takes the bottle on the table utilizing full sterile facilities. The hood is removed from the bottle using a toothless forceps or simply floated out. It is then put in the jaws of a box folder, normally used for folding silicone lenses prior insertion. Using a standard silicone lens insertion forceps the Hood is grasped making sure that the entire lens is engulfed in the lips of the holder. It is imperative that the lens be always kept moist. It is then coated with viscoelastic solution prior insertion.\

Insertion of the Hood

The correct time for insertion of the Hood in the anterior chamber is after completing the rhexis, finishing the hydrodissection and making sure the nucleus rotates well. The anterior chamber is inflated with viscoelastic. (HPMC works best)

The Hood is now inserted in a folded stage, held in the holder. Once the lens crosses the + mark of the Hood, the forceps is released which permit the Hood to unfold. Be sure to release the Hood keeping the convex side towards the dome of the cornea. Next, viscoelastic is again injected between the Hood and the iris, thus pushing the Hood into intimate contact with the endothelium. The Hood sticks by itself to the endothelium. Wait for about 30 seconds, which allows the Hood to settle itself, and the phaco procedure may be commenced.

Phacoemulsification procedure with the Hood

Phaco is allowed to proceed normally with no restriction of technique for the primary phaco or, the subsequently following, I/A or IOL insertion. Any technique can be used. Four quadrant technique to chopping or the newer vertical phacoemulsification. There is no problem if the HEMA Hood is accidentally touched, it simply moves and then automatically slides back into position. Even with full irrigation/ aspiration, there is no discernible movement of the hood.

The IOL can be injected or simply inserted with forceps. The only additional care needed, is at the time of inserting the IOL. When the injector is placed in the tunnel, just prior its exit from the tunnel into the anterior chamber, remember to enter at a slightly steeper angle, tilting the IOL towards the iris to prevent the edge of the Hood from being nudged. Again, even if it occurs, the Hood will only slide away, like a decentering soft contact lens and then shift back into position smoothly.

Removal of the Hood following surgery

On the completion of the surgery, after the IOL has been inserted, as a last step, take out the Hema Hood. The technique for removal is simplicity itself. Take a 5.00 ml syringe filled with BSS with a blunt 26 G bent cannula. Insert it into the anterior chamber and squirt at the edge of the Hema Hood. As the jet of BSS impacts at the edge of the Hood, it dislodges the Hema Hood off the endothelium of the cornea. The Hood then simply floats onto the iris. Using straight, plain forceps, the Hood is held and simply removed. The Hood being a pure Hema material oozes out with no problem. Though the Hood is supplied as a single use, disposable item, it can be washed carefully, placed in BSS, and the re-autoclaved.

Post Surgical Evaluation

The eye is always very quiet. In over 775+ cases done over the last 2 years, no problem has been encountered. The case selection is based on whether it is a hard cataract, which will need more ultrasound time and if the cell counts is poor.

It is used as a routine

a) If the cell count is 1500 or less.
b) If the other cornea has suffered decompensation for any reason.
c) When students are being taught phacoemulsification in a firm or hard cataract as it protects the endothelium very significantly.
d) In all cases of suprahard cataracts (6+ or over)

Endothelial Cell Analysis

Analysis of the Endothelial Cells with the Hema Hood has been carried out in detail in the last 14 months with the Topcon Non-Contact Specular Microscope SP-2000P. The data is transferred to a Pentium III computer and analyzed with the Topcon "ImageNet" Cell Analysis software which give good, reproducible, stable readings. Initial data would seem to confirm what we had originally conceived. The cell protection ability of the Hood seems very good.

To really know if the system works, two independent observers did a series of evaluation of the author's cases. All cell counts were done with the Topcon Non Contact Specular Microscope SP-2000P. The data being analyzed with the Topcon "ImageNet" Cell Analysis software.

The authors average cell loss, using the tangential chop for medium cataracts, vertical phacoemulsification for hard cataracts, and the Side chop/Saddle-hump technique for suprahard cataracts. WITHOUT the use of the endothelial cell protection device, the Hema Hood were

Soft cataracts	0 – 2.2%
Medium cataracts	1.2 – 4.4%
Hard cataracts	2.4 – 6.4%
Suprahard cataracts	5.8 – 12.3%

Note: The accuracy of the Topcon Non Contact Endothelial Camera technique has a maximum accuracy of (+/−) 2 - 3 %.

With the usage of the Hema Hood, three types of cataracts were considered and analyzed; medium density, hard cataracts and suprahard cataracts and their cell counts were done individually. Representative analyses are displayed below.

Endothelial Cell Difference in "Medium" Density Cataracts with the Hema Hood

Endothelial cell difference in "MEDIUM" density Cataracts with the Hema Hood

Sr No	Patient	Pre-Op	Post Op	Difference	% Variation
1	HB	3880	3768	112	2.88%
2	CG	2464	2386	78	3.16%
3	MB	2658	2600	48	2.18%
4	SR	3668	3633	35	0.95%
5	AS	3348	3264	84	2.50%
6	HM	4014	3872	142	3.53%
7	RT	4340	4450	10	0.23%
8	CD	3964	3856	108	2.72%
9	SM	2884	2800	84	2.90%
10	DC	4432	4318	114	2.57%

Endothelial Cell loss as evaluated by a Topcon Non Contact Endothelial camera: Average Variation = 2.36 %

Endothelial cell difference in "HARD" Cataracts with the use of the Hema Hood

Sr No	Patient	Pre-Op	Post Op	Difference	% Variation
1	WC	3448	3320	128	3.71%
2	RC	2862	2764	104	3.62%
3	DS	4226	4142	84	1.98%
4	FD	3086	3012	74	2.39%
5	TH	5062	4956	106	2.09%
6	HR	3838	3760	78	2.03%
7	CU	3862	3770	92	2.38%
8	YD	4208	4052	158	3.75%

Endothelial Cell loss as evaluated by a Topcon Non Contact Endothelial camera: Average Variation =2.74%

Endothelial cell difference in "SUPRAHARD" Cataracts with Hema Hood

Sr No	Patient	Pre-Op	Post Op	Difference	% Variation
1	SH	2864	2720	144	5.03%
2	DK	2874	2722	154	5.35%
3	NR	4148	3960	188	4.53%
4	TD	3864	3736	128	3.32%
5	FT	4006	3842	164	4.09%
6	RK	2884	2798	86	2.98%
7	FN	3286	3158	128	3.89%
8	TC	4428	4236	192	4.33%

Endothelial Cell loss as evaluated by a Topcon Non Contact Endothelial camera: Average Variation = 4.19%

Hema Intracameral Contact Lens Endothelial Cell Loss: Average Cell Loss in Phaco with the Hema Hood

With any type of lens density, irrespective of the length of the procedure, the cell loss stays in the narrow range of 3-5%.

Subsequently, endothelial cells evaluations were done using the Hood. The cells differences showed that whether a hard or a suprahard cataract was done the difference remained virtually identical. Even in suprahard cataract, which in the authors own series showed a gross variation, in the Hood series showed a very stable cell count, which hardly varied. With any type of lens density, irrespective of the length of the procedure, the cell loss stays in the narrow range of 3-5%.

Note: The accuracy of the Topcon Non Contact Endothelial Camera technique has a maximum accuracy of (+/−) 2 – 3%.

Interestingly in a number of cases of suprahard cataracts after the surgery was over and the Hood was removed, a clear demarcation line, almost like a watermark was left. The area protected by the Hood was very clear but a diffuse haze was visible outside the boundaries of the Hood. The haze was there the next day and then gradually faded off.

It would thus seem that the Hema protection device is functional. It is particularly useful where the cells are compromised either in quantity or even quality and where the surgeon feels that the endothelium is at risk. It is particularly useful to use when phaco is been done on a case, which has been grafted before.

It also makes for an excellent teaching device, as even with prolonged ultrasound power being used in the chamber the endothelium is not at any risk.

In Summary: In the long Odyssey of Phaco, the Hema Hood is an effective technique in preserving the vital endothelial cells in the Phaco procedure. Usage of the Hood permits phaco even in endothelially-compromised corneas, with safety.

It has been truly a honor for me to have been selected to present this very prestigious **Lim Lecture.**

I am very grateful to The Asia-Pacific Intraocular Implant Association, to have given me this honor.