Manual Extracapsular Surgery Mini Nuc Technique

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The many different technologies in cataract surgery and intraocular lenses available today leave some ophtalmologists confused. The proposed technique is one of the most cost effective procedures, while at the same time the outcome is considered to be of the highest quality cataract surgery.

Basic surgical principle is to perform cataract surgery under the following conditions:

1. Anterior chamber maintaining system, achieved by continuos BSS flow from BSS bottle through anterior chamber maintainer (ACM) to the eye.
2. The above system provides the ability to con trol intraocular pressure during surgery.
3. Availability of both these conditions provides a system for controlling any surgical technique.

This system opens new avenues for manual extra cap. It proves to be equally effective in countries where sophisticated instrumentation may not be available as well offering the possibility of reducing the constantly escalating surgical expenditures.

First stage: The first stage of the MINI NUC technique (mini nuc stands for mini nuc(leus)) is the preparation of two entries made by a 1 mm wide stiletto knife. The incision at 11 o'clock is used for introducing manipulation instruments like capsulotomy needle, hydrodissector cannula, aspiration cannula, spatula for epinucleus manipulation and Sinsky hook for lens manipulation. The second entry is for introducing the anterior chamber maintainer (ACM) performed by the same stiletto knife at 5 o'clock, scleral tunnel-like incision. This entry is so designed for introducing the ACM and for stable fixation. The ACM is made like a cannula, 2.5 mm long, with small ringe elevations on its outside surface. It has a 1 mm outside dimension and a 0.6 mm inner diameter (nearly aproximating a 20 gauge needle). The ACM is connected by a silicone tube to a BSS bottle hung on a post where the bottle height can be changed according to the IOP selected during the different stages of the operation.

Positive IOP during cataract surgery is advantageous due the following reasons:

a) From a surgical point of view the ACM system provids the best available controlled surgery, a condition in which any surgical maneuver will not disturb the normal internal anatomi cal relationship in the eye. These conditions are achieved by the ACM constantly irrigat ing the eye and simultaneously controlling the positive intraocular pressure. Any fluid lost is instantaneously recovered, due to the large in ternal diameter of the ACM, ensuring the mecha nism of controlled surgery.

b) There is constant flow from inside the eye out. This flow continuosly washes out from the eye during surgery all debris of blood, pigment, and leftover cortical material. Practically this flow keeps the ye clean of any future inflam matory particles.

c) Low turbulence and low fluctuation of AC depth during surgery result in low quantities of prostaglandin and low leukotriens, which

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also indicates less post-operative inflammatory reaction.

d) Bacteria is mostly prevented from entering the eye, and constantly washed out of the eye if it does enter.

e) The BSS bottle can be used as a reservoir of pharmacological drugs to be continuously fed to the eye, such as adrenalin 1:1,000.000 to keep the pupil dilated, antibiotics, or any other drug of choice one wishes to have during surgery.

At present state, the art of planned extra cap does not follow this principle. Thus there are long periods of time when the eye is under hypotony.

Generally in planned extra cap without ACM or positive IOP there are long periods of time when the eye is under hypotony or low IOP, causing technical difficulties during surgery and at the same time increasing the possibility of post-operative inflamation.

Capsulectomy: To create a true capsular bag, it is obligatory to perform a round, continuous tear with smooth edges and no break at any point by capsulorhexis. The term round does not relate to a geometrical configuration but rather to any configuration without a protruding angle: a circle, ellipse, heart or clover leaf shape. Any radial tear at the capsulectomy margin would perform a false bag, causing the IOL loops (not necessarily the optic part) to find themselves to be in touch with uveal tissue and in due time could cause complications like hemorrhage, uveitis, macular edema, etc. The cystotome of preference is a 25 gauge needle. The bevelled tip which is 0.3 mm long is bent over at 90°, then twisted an additional 90° so that the cutting edge lies parallel to the main axis of the cystotome. Using a cystotome there is a need for only a 1.0 mm opening for the capsulotomy maneuver, while the anterior chamber is well maintained by the ACM. When using forceps an opening of 3.0 mm is needed, obviously inducing an open system, which forces us to use viscoelastic material to maintain the AC during capsulotomy.

Collapse or shallowing of the AC is associated with an anterior movement of the lens. If this occurs during capsulectomy it might result in momentarily uncontrolled tear, often extending to the equator. It is essential to force the lens backward as much as possible by maintaining high IOP. High pressure in the anterior chamber pushes the lens zonule diaphragm backwards. This results in maximal relaxation of the anterior capsule, a manipulation which allows maximum control of the capsulectomy, and not depending on viscoelastic material. The propagation of the capsular tear is best evaluated in the presence of a bright red reflex. In its absence, even in mature cataract, one can use other guidelines such as capsule reflex, defraction at the capsule tear area, or by following the movement of the free capsule flap induced by the ACM flow.

It is ideal to create a capsulotomy not larger than 6.0 mm in diameter, to avoid the zonules which are attached 1.5 mm on the anterior capsule measured from the equator. A small capsular opening 5.0-6.0 mm limited to the zonule-free area inside the zonular frontier, means a difficult, sometimes impossible nucleus expression by conventional external pressure. The application of external pressure in such cases may result in vitreous loss through the torn zonules or in pushing the nucleus into the vitreous. In order to overcome this difficulty and avoid these complications, many surgeons perform one or more radial tears at the capsulotomy margin (relaxing incision, episiotomy). These radial tears, seemingly harmless, virtually convert a "true bag" into a "false bag" and all the efforts to perform a round capsulotomy by capsulorhexis were actually in vain. It is essential to save the round capsolotomy as this would keep the OIL isolated from the uvea, preventing most complications due to loops touching the uvea.

How to achieve this goal of removing the nucleus while deepening the round capsulotomy intact? The following is the way:

Nucleus Manipulation: Nucleus extraction is performed in twq steps. The continuous small capsule margin stands a high degree of stretch without tearing. The adult nucleus diameter is usually larger than the diameter of the round capsulotomy. In manual ECCE with big limbal incision open eye system, the expression of the nucleus has to be induced by outside pressure on the eye. This pressure is transmitted to the inner structures of the eye, producing pressure differences between the induced high pressurre in the eye and the atmospheric pressure outside the eye, thus pushing the whole zonule capsule diaphragm and the nucleus anteriorily. This pressure transmitted anteriorily is not directed to the nucleus specifically, but the pressure rather spread to the whole area of zonule capsule diaphragma. This may cause a possible complication such as vitreous loss, tear of zonules, tear of capsule, or even nucleus drop into vitreous, complications which all of us encounter and try to reduce to a minimum. The way to prevent these complications is explained as follows: The mini nuc tecnique is a closed system results in a steady fixed lens in the presence of deep AC which leads the way to dissect the crystalline lens in situ and isolate the smallest nucleus possible. The positive pressure in the AC pushes the zonule capsule diaphragm backwards and creates a counterforce to the resistance induced by the capsulotomy margin to the forward passage of the nucleus. The slow controlled delivery of the nucleus through the round capsulotomy can be achieved due to the ample space present in the deep AC. It is very important to remember that deep AC is a result of positive IOP and steady diaphragm. This makes it feasible to deliver the nucleus and not to break the round margin of the capsulotomy during this process. Viscoelastic material alone cannot play this role as the maneuver of the nucleus would tend to collapse the AC (some viscoelastic material would leave the eye) and prevent mostly the delivery of the nucleus to the AC, while wi the ACM and BSS you can repeat nucleus delivery to the AC again with success.

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The possibility to dissect the lens in situ in the closed eye during manual mini nuc extra cap technique led us to the recognition of a new division of the crystalline lens anatomy consisting of three components:

a) Cortex, soft material (can be aspirated)

b) Epinucleus, semi-soft (can be aspirated or expressed)

c) Hard core nucleus, hard (can bee expessed or mechanically broken and exprressed)

The following is the way of extracting the nucleus from the eye:

Hydrodissection: Crystalline lens separation to its three components in the closed system startsfirst with the aspiration by Anis cannula 0.4 mm pore size, of the anterior cortical and epinucleus material exposed after the capsulotomy is completed. The bottom o the formed crater is the antrior part o the hard core nucleus. To separate the crystalline lens to its components, and to facilitate their expression and removal, hydrodissection is performed, using a 1 cc syringe (do not use a 2 or 5 cc syringe as surplus accumulation of BSS in the crystalline lens might break the posterior capsule), and a specially designed cannula, in which the bent part is 4 mm in length and slightly conoidal at is proximal part, with slightly sharp pore edges. It is so designed to penetrate lens material with minimum amount of force and maximum accuracy. The cannula slides along the exposed hard core nucleus, to be inserted obliquely (at 12:00 o'clock) into the junction of the hard core nucleus and epinucleus, 0.1-0.3 cc BSS enforced by injection, engulfs the nucleus instantaneously and forms the hydrodissection. The BSS hydrodissection creates a demarcation line, usually clearly seen by the light reflection (golden ring) created between the nucleus and the epinucleus, or between the epinucleus and the cortex.

Hydrodissection, a general term, is commonly used to describe separation of cortical lamella in a non-specific location or between cortex and capsule. Hydrodissection introduced by the author 10 years ago was modified and improved to adjust it to our present technique under a closed system. We find anatomically guided hydrodissection a highly effective surgical technique to separate the lens lamella specifically between the hard core nucleus and the epinucleus, or any place the surgeon chooses. (Thus we call it selective hydrodissection of the lens). This technique enables the surgeon to perform selected hydrodissection in any lamella level he chooses. The continuous controlled ACM flow facilitates separation of the lenticular components during hydrodissection. The positive pressure in the AC using the ACM pushes the posterior capsule backwards and creates a counterforce to the anterior movement of the hard nucleus induced by the cannula from behind the nacleus. This way the smallest possible hard core nucleus is isolated, and is usually small enough to be delivered through the round capsulotomy. ***Bringing the nucleus into the anterior camber:*** After hydrodissection the hydrodisecctior cannula is lodged in the newly created space between the epinucleus and the hard core nucleus, then introduced by slight force and small strokes up and down behind the hard nucleus. This part is performed usually at the 12:00 o'clock position where hydrodissection was started. The positive intraocular pressure in the anterior chamber (AC) pushes the posterior capsule and the cortex attached to the posterior capsule backwards and creates a counterforce to the anterior movements of the hydrodissection cannula which is now located behind the hard core nucleus. This manuever is considered a key to the success of mobilization of the nucleus before actually bringing the nucleus to the AC. One can use a Sinsky hook to rotate the nucleus. This facilitates the introduction of the hydrodissector cannula behind the nucleus. This way the smallest possible hard core nucleus is isolated and is usually small enough to be delivered through the round capsulectomy, even if some epinucleus is still attached to it, as is commonly seen. This part of the surgery is very important and not too difficult to perform. It is advisable to elevate the BSS bottle to 50-60 cm above the eye, and not to be afraid to push and manipulate the hydrodissector behind the nucleus; due to the hydrodissection this maneuver is not so difficult. Rupture of the posterior capsule by the cannula is quite rare. One has to be sure that the hydrodissection was properly done, using 0.1-0.3 cc of BSS only. Too much quantity might be lodged in the posterior part of the crystalline lens and break the posterior capsule. Without proper hydrodissection the nucleus does not separate from the epinucleus and from the cortex and form one unit. External pressure might on this occasion cause unintentional ICCE result.

Nucleus evaluation and scleral incision: The size of the hard nucleus is evaluated during its presence at this stage in the AC and helps determine the size of the scleral incision needed for that particular nucleus. This is even more true for those who still use limbal incision, as only at this stage do we judge the size of the incision. Thus it might be better to perform limbal incision before the nucleus is in the AC. The size of the nucleus will guide the surgeon as to the size to be performed at the limbus. Up until this stage the AC is closed, a true closed system. The scleral incision should be 1/2 thickness depth, performed 2.5 mm behind the limbus. The shape of the incision is curved slightly backwards. Its apex point is nearest to the limbus. It is recommended to have a symmetrical biconvex dissector knife angled 60°. It is essential to have sharp cutting edges on both sides. The straight diamond knife is not recommended

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or this procedure, a 60° angled one can do. The liamond knife is excellent but it is very sharp and ieeds much expertise to work with. Scleral dis-ection is performed at half thickness in a given amella until reaching clear cornea!

Be carefull not to penetrate earlier into the AC, nto the angle, otherwise the iris will tend to rolapse and you ask for complications and diffi-ulties you really don't want to happen. A very harp keratome is used to perforate to the AC, the ine of descement cut is observed through high nagnification of the microscope on the anterior urface of the keratome. It is essencial to follow he line of descement while the incision is enlarged ight and left, the inner incision should be larger han the outer scleral incision, forming a funnel-haped scleral tunnel.

A plastic glide 3-4 mm wide, 0.3 mm thick and cm long is intrroduced through the scleral inci-ion to the AC directed under the nucleus. It is bsolutely essencial to have the glide, otherwise he nucleus will not be well guided to the inci-ion. A slight external pressure is induced on the lide at the inner limbal area, forcing the nucleus o be engaged in the inner incision of the scleral unnel-shape tunnel, preventing leakage of BSS hrough the scleral incision. When the nucleus is vell lodged in the inner aspect of the incision, hen external scleral pressure is induced moving he pressure gradually away from the limbus. The BSS bottle is located 60-70 cm above the eye, cre-ating 40-50 mg of mercury IOP in th AC. This pres-ure helps to produce hydro-expression forcing the ucleus out by itself or aided by external pressure.

External pressure at this stage would not cause he AC to collapse as the AC is kept deep by the tatic pressure of the BSS bottle inflow, produc-ng an internal pressure which is higher than the xternal induced pressure. During the nucleus assage through the sclear tunnel, it sheds itself rom any remnant of epinucleus left attached to it nto the AC; thus the smallest possible nucleus is created, like a newborn baby, the remnants of epinucleus are observed as left over in the AC. The nucleus proper is much smaller than the adult nucleus we used to see while performing planned ECCE, thus the formation of small hard core nucleus led us to call the whole present surgical system a mini nuc(leus) system. The mini nuc manual system enables manipulation of a small nucleus through a 5.0-6.0 mm scleral incision. Thus no stitch is needed to hold the incision closed, if so desired. The end result is a small incision, no stich, mini nuc technique.

Handling the epinucleus and cortex: After the nucleus is extracted the positive IOP creates an inflated capsular bag, facilitating the extraction or aspiration of the epinucleus and cortical mate-rial. The epinucleus extraction is performed as follows: -A spatula is introduced into the AC through the scleral incision, manipulating it smoothly right and left, freeing the epinucleus from any attachment to the cortex. The AC might get shallower during the manipulation which is advantageous for the purpose of freeing the epinucleus. The free epinucleus finds its way to the AC and is hydroexpressed out by slight pres-sure on the posterior lip of the sclear incision. This maneuver might take some time and need deter-mination, as it has to be repeated as long as the epinucleus is still attached to the cortex. In stub-born cases the spatula might be introduced from the side tunnel entrance, penetrate the epinucleus and direct it to the AC. An aspiration cannula with 0.3-0.4 pore is introduced at the limbal side open-ing, not through the scleral incision. Thus the AC stays inflated and does not collapse during aspira-tion. The scleral incision is a self-sealed incision and does not tend to open during cortical aspira-tion through the side 1 mm opening. This is a very important advantage as aspiration is performed under controlled condition. This controlled con-dition is most dramatically appreciated, particulary when one has to handle a complication like poste-rior capsule tear while the cortex is still in its place. In most cases the vitreous face does not tear simultaneously and is pushed backwards by the ACM flow. It is essential to lower the BSS bottle to 10-20 cm above the eye. As only a small cannula is introduced for aspiration, there is no fluctuation of the AC depth during aspiration. A steady fixed depth of AC is a very important fact, it prevents enlargement of the posterior capsule tear, which usually is observed due to fluctuation in AC depth using I/A system, and prevents engagement of the vitreous during aspiration. In most cases one can comfortably finish cortex aspiration in the presence of a torn posterior capsule. If the tear is small, the tear can be converted by the principle of capsulorhexis to a round posterior capsulotomy, facilitating lens implantation, ensuring that it will be implanted in the bag with no vitreous involvement.

In cases when the vitreous presents itself in the AC, the low flow and low pressure in the AC facilitates controlled vitrectomy, again keeping the AC in constant depth, with no fluctuation. Towards the end of vitrectomy a spatula is used to feed the vitrectomy, with vitreous bands attached to the scleral wound.

The side 1 mm. entrance in the limbus enables me to perform this two-handed vitrectomy, exploring the vitreous strands engaged in the scleral incision by pulling them towards the vitrectome by the spatula. Controlled IOP during complicated conditions as such is most appreciated because it produces the most comfortable circumstances for controlled surgery in complications. This is true for any technique. Even in phacoemulsification technique it is advisable first to introduce an ACM amd perform a 1 mm. entrance at 11 o'clock, before starting the phacomulsification. Thus one is always ready to confront any complication such as posterior capsule tear, with the best controlled condition to overcome the complication.

Lens implantation: Small incision induces new rules for manipulating the IOL into the eye. It is especially true for the scleral tunnel or corneal tunnel currently supposed to be the state of the art. There is a common misunderstanding correlating the optical size of IOL to the scleral incision dimension. It is a commonly accepted fact that the 6 mm optic dimension IOL is the right size to introduce the IOL through 6 mm scleral incision, but this is not necessarilly true. The loops base of extension from the optic part add up to 30% of the non-flexible portion of the IOL to be introduced through the scleral incision. That is the reason why a 6 mm IOL hardly can pass through a 6 mm scleral incision. The scleral tissues have viscoelastic properties which allow provisional extension of the scleral incision during forcing the IOL through the scleral tunnel. This fact facilitates IOL implantation under the above conditions, but in designing the new generation of IOLs this fact has to be taken into account. Soft IOLs overcome this problem by indicing a new principle of IOL implantation technique, but still most IOLs are made of PMMA. The only way to overcome the above problem is by designing the IOL: first to reduce the non-flexible loop base extension by a symmetrical design like the Blumenthal lens made by Domilens, or any other design which would consider reducing the extra mass to the optical part. Another important fact in manipulation of IOL into the eye is the following. Using only BSS fluid holding the AC depth steady, it is difficult to manipulate the second loop into the capsular bag by forceps through the scleral incision. It is much more preferable to introduce a lens hook from the 11 o'clock side entrance. This means that at least one hole extended out from the optic part would make this manuever possible. Another general suggestion is to have in each apex of the lens loop a hole to faciliate loop manipulation in cases where the loop was not successfully introduced into the capsular bag. It is not uncommon to have the lower or upper loop to be found in the AC anterior to the iris. These holes would permit the surgeon (both experienced and inexperienced) to relocate the loop into its position in the bag without much difficulty. This type of lens where both loops have holes in the apex position is not common on the market. Hanita Lenses recently introduced this type of a lens loop. There are other lenses with holes in the loop but mostly only in one loop. This type of lenses is an excellent desing for scleral fixation lenses where necessary.

Suturing: The mini nuc technique allows cataract extraction through a scleral incision 5.0-6.0 mm long, fashioned to need no sutures for closure. It is too early to conclude that the no stitch approach gives the best astigmatic ressults. With the positive IOP mini nuc technique another advantage is demonstrated during the act of suturing. The IOP is chosen to be 10 mmHg. This pressure provides the best condition for adaptation of the scleral wound lips of the scleral tunnel. Small bite sutures promise best adaptation, and probably best overall astigmatic results. No stitch with 6.0 mm scleral incision tends to move slightly against the roll in 3 months, but edge to edge adaptation with no overlapping prevenst the tendency of against the roll astigmatism in 3 months. The wound is tested for leakage by increasing the IOP (by raising the BSS bottle), another advantage of this technique.

A metal anterior chamber maintainer is currently available and now a new model is coming up made of plastic, which is easy to use. There is also a specific needle for capsulorherix which is bent 90°, and then another 90° on its axis. This needle makes capsulorherix simple to perform. A specific conoidal cannula is used for hydrodissection and a stiletto knife is used to perform the mini-tunnel for the ACM fixation. A 500 cc bottle is used for eight cases usually. Controlled surgery depends on a condition where any surgical maneuver will not disturb the basic normal internal anatomical relationship in the eye. The best way to achieve controlled surgery is by continuosly irrigating the eye and simultaneously controlling the intraocular pressure. Thus during my surgical maneuver the amount of fluid lost is instantly recovered. The use of viscoelastic material can achieve controlled surgery only at specific stages of the surgery but not at all stages, while the anterior chamber maintaining system with ACM provides the precondition for controlled surgery throughout all the time needed to complete cataract surgery.

Under positive IOP the BSS in the eye, with very low turbulence and steady flow rate, creates the best millieu to the point where the anatomical relationship in the eye is intact and offers the precondition for controlled surgery. Only 30-40 cc of BSS is used in this mini nuc technique. During phaco, even with a low flow technique, the amount of BSS used during the operation is from 10 t0 20 times greater than that used in the mini nuc technique . The other advantage of the mini nuc technique is the freedom from the necessity to use viscoelastic material, as a steady flow of BSS ensures a constant depth of the anterior chamber.

In summary, the mini nuc technique is cost effective, the surgical time is very short. It is the most inexpensive procedure known today for cataract surgery. The learning curve is not too long. Getting used to the tchnique enables you to reduce surgical and post-operative complications to a minimum. No expensive sophisticated instruments are needed. One feels comfortable with this technique in any part of the world, in the affluent countries or in countries which cannot afford sophisticated instruments. With the leasst instrumentation, one has in hand a system with shich you can achieve surgery as good as anywhere in the world.