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Small Incision Sutureless Cataract Surgery (SICS) Pearls: A Step-by-Step Guide

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When I was learning SICS as an International Fellow, I wished there were a detailed, step-by-step guide to learning Sutureless Small Incision Cataract Surgery (SICS) to help me shorten my learning curve. Throughout my fellowship and in the years since, I have tried to record everything I've learned from my SICS mentors, as well as insights gained while leading high-volume outreaches over the last several years in Ghana. Below are pearls I've compiled for each step of the SICS technique that I hope will be help accelerate the learning process for others. This is intended as a guide to SICS basics. Future iterations will include pearls for dealing with complexities such as pseudoexfoliation, very miotic pupils, traumatic cataracts, uveitis cataracts, etc.

Linked here are three representative SICS cases (Case 1 – White Cat SICS with CCC, Case 2 – SICS Linear Capsulotomy Technique, Case 3 – SICS Traumatic Cataract) which will help you get a feel for the technique and some of its variations. There are numerous ways to perform this procedure and new innovations are always coming along. When you are beginning, however, it is helpful to choose one technique and master that, then learn other variations. I hope you'll find these pearls useful. I'd love to hear your feedback.

I. Surgical Preparation and Drape
   A. In Pre-op
      a) Clean face / trim lashes in pre-op
      b) Dilating drops (phenylephrine 2.5%, tropicamide 1%, NSAID) and betadine drops applied. Designate someone to check block before patient is brought to OR table. Re-drop if not maximally dilated.
      c) Peribulbar block – Apply pressure device. Designate someone to check block before patient is brought to OR table. Re-block if there is significant motility / eyelid squeezing.
   B. On Table
      1. Surgeon cleans around eye with betadine swabs x 3
      2. Generous application of betadine onto surface of eye.
      3. Lid speculum is placed to hold eyelids open

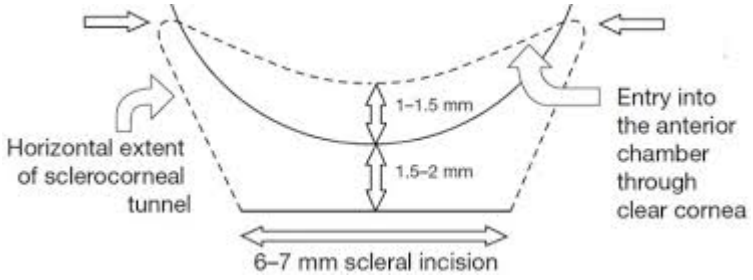
II. Surgical Approach
   A. Generally, a superior approach is used (surgeon sits at head of operating table)
   B. Temporal approach may be desirable if:
      a. The patient has a very deep set eye

b. The patient has a very small palpebral aperture
    1) If lids are very tight, a lateral canthotomy should be performed to provide adequate exposure
c. There is significant against-the-rule astigmatism

III. Bridal Suture (optional, but recommended during the learning curve)
A. An angled, toothed forceps is used to grasp and elevate the superior rectus muscle.
B. A 4-0 Silk bridle suture is then placed beneath the elevated superior rectus muscle (careful not to penetrate the globe)
C. The suture is used to rotate the eye inferiorly and is clamped to the drape using hemostat clamps.

IV. Conjunctival Peritomy
A. The conjunctiva and Tenon's tissue are grasped with a calibri forceps and elevated. Wescott scissors are then used to cut down through the elevated conjunctiva and Tenon's to bare sclera. After initial cutdown, the Wescotts are used to bluntly dissect Tenon's from the sclera and to make a radial cut-down, exposing bare sclera.
B. Light cautery can then be applied to the sclera. Cautery is optional, but usually improves visualization and is recommended during the learning curve. Exercise caution not to over-cauterize as this can cause contraction of the sclera with induced astigmatism and impaired wound healing.

V. Sclerocorneal Wound Construction
A. Initial linear incision
    a. A calibri forcep is used to grip the bare sclera securely.
    b. A crescent blade is turned perpendicular to the sclera to create a 6-7mm, ⅓ to ½ thickness incision. This can be a straight incision or a slight frown-shape (frown shape may lessen induced astigmatism, but is more difficult to perform), with the center of the incision approximately 1 mm posterior to the surgical limbus.



B. Sclerocorneal tunnel
    a. A calibri forcep is again used to grip the bare sclera securely. The tip of the crescent blade (either metal or diamond blade can be used) is then placed into the partial thickness linear incision, keeping the blade in the

plane of the cornea. The tip of the blade is advanced into clear cornea using a controlled sweeping or wiggling motion at 1/3 to ½ depth. **Creating this tunnel at the correct depth is critical to the success of the procedure and is one of the most challenging skills to acquire.** If the wound is too superficial, the blade will cut through the anterior lip of the wound and cause the wound to leak. If too deep, there is high risk of premature entry into the anterior chamber, resulting in iris prolapse, iridodialysis, and sometimes vitreous prolapse. Consistently achieving the correct depth requires practice. The striated metal of the crescent blade can be a helpful guide when trying to find the correct plane. If the striations can be seen on the metal of the crescent blade, then you are too shallow. If you can barely see the blade at all (obscured by the white sclera), then you are too deep. Generally, when you are at the correct depth, the crescent blade should appear as a flat grey color, without detail. Of course, if you are using a diamond blade the appearance will vary, but the same principle applies.

b. The importance of creating this tunnel in the correct plane cannot be over-emphasized. **If you find you are too deep or too shallow when initiating your tunnel, stop immediately and do not extend the wound.** Instead, re-start your tunnel at a new site along the initial incision. Once you achieve the correct plane, you can then then extend the wound as described below with little or no adverse consequence. If, however, you extend a tunnel at improper depth, you will likely experience the complications listed above and the wound will probably require suturing.
c. Once the correct plane is achieved, the tunnel is extended anteriorly and side-to-side by moving the crescent blade in a repetitive semi-circular motion. The tunnel should extend about 2mm into the clear cornea. When extending the tunnel, care should be taken to maintain the crescent blade in a neutral position, keeping the blade within the same tissue plane by following the curved contour of the cornea. When extending the wound nasally, the blade should be flared out nasally. Likewise, when extending the wound temporally, the blade should be flared our temporally, thus creating a funnel-shaped tunnel that is several millimeters wider internally than externally. In later steps this funnel shape will help bring the nucleus to the wound for delivery.
d. Keratome entry into the anterior chamber
    1) Once the sclerocorneal tunnel has been completed, a keratome is then inserted to the end of the tunnel (2mm into clear cornea), where it hits a “dead end”. At this point, the heel of the keratome is lifted and the tip of the blade advanced “toe down” toward the center of the pupil, entering the anterior chamber.
    2) Once the anterior chamber has been entered with the keratome, the eye is filled with viscoelastic.

VI. Creation of accessory side-port incision

A. After the eye has been filled with viscoelastic, but before the internal wound has been extended, the eye anterior chamber is very stable. This is a good time to create an inferior side-port incision around 7:00 (the video linked above shows the sideport being made at 9:00… we prefer to make it around 7:00). This incision is created with a 15 degree blade, or can also be made with a keratome in biplanar fashion, just like a phaco wound. This accessory wound allows a much easier angle for safe removal of sub-incisional cortex removal with the Simcoe cannula. If the cataract is milky white, this step can often be skipped as the cortex has been liquified and will require little stripping.

B. Once initial keratome entry (not yet extended to full width) and side-port wounds have been performed, attention is turned to the capsulotomy.

VII. Capsulorhexis

A. Continuous Curvilinear Capsulorhexis (CCC)

a. When pupillary dilation is adequate and trypan blue is available, a continuous curvilinear capsulorhexis is the most stable, reliable form of capsulotomy. Whenever it is possible, CCC is the technique of choice.

b. Capsular staining is performed by injecting an air bubble in the anterior chamber, followed by trypan blue dye. The air bubble protects the endothelium from staining while allowing the dye to settle on the anterior capsule. After staining for a few seconds, the dye is flushed out of the anterior chamber with viscoelastic.

c. CCC is performed by inserting a bent-needle cystotome (bent 26ga needle) through the keratome incision, creating a nick in the anterior capsule, raising small flap, and using the needle tip to “walk” the flap around in a circular fashion, to complete a 360 degree capsular opening. Since SICS is typically performed on very advanced cataracts and a red reflex is often not visible, trypan blue is often critical to the success of this step. Once curvilinear capsulotomy has been completed, you may then proceed to step (F), extending the main wound.

B. Linear Capsulotomy (LC)

a. Linear capsulotomy can provide a safe and efficient alternative to CCC when pupillary dilation is poor or trypan is not available. Advantages include the ability to perform this capsulotomy on virtually any cataract type (regardless of visibility), without capsular dye, and to do so very quickly. The disadvantage is that this capsulotomy can be less stable than CCC.

b. First, the keratome is used to extend the main wound from side to side as described in step (F). Then, a bent needle cystotome or keratome is used to create a horizontal, linear opening across the superior ⅓ of the

anterior capsule (from about 10:00 to 2:00). Gentle hydrodissection, as described in step (G), is then performed, elevating the superior pole of the nucleus through the linear opening. This pole is then gently dialed into the anterior chamber as described in step (H). Care must be taken to minimize manipulation when attempting to hydrodissect and dial the nucleus into the AC as excessive manipulation can lead to extension of the linear capsulotomy with subsequent capsular instability and possible vitreous loss.

c. Experienced surgeons sometimes deliver the nucleus directly from the bag without dialing the nucleus into the anterior chamber. In general, this technique should be reserved for smaller nuclei (such as those seen in hypermature cataracts with liquified cortex) as this technique may carry higher risk of capsular compromise if performed with larger nuclei. Expression directly from the bag can be performed using a fishhook technique (Bidya Pant Video), or using gentle hydro- or visco-expression (Deepak Khadka Video).

C. V-shaped Capsulorhexis (VC)

a. V-capsulotomy is another safe and efficient capsulotomy technique which can be performed when pupillary dilation is poor or trypan is not available. This technique can likewise be performed on any cataract type (regardless of visibility), without capsular dye, and can be done very quickly. A disadvantage is that it is not as stable as CCC and may lead to higher rates of of posterior capsular opacification (PCO).

b. The tip of a straight 26ga needle is inserted through the initial keratome incision, to the distal side of the anterior chamber. The bevel of the needle is turned sideways, exposing its cutting edge. The cutting edge is then used to incise the distal capsule and draw back at a slight inward angle. The same maneuver is then performed again, drawing the needle back at the opposite angle, meeting the first incision to create the apex of the “V”, leaving a triangular flap with hinge distal to the surgeon. The triangular flap will be amputated at its base several steps later, following IOL insertion.

D. Can opener capsulotomy (CO)

a. Can opener capsulotomy is a another safe and efficient capsulotomy technique which can be performed when pupillary dilation is poor or trypan is not available.

b. CO is performed by using a bent needle cystotome to create numerous tiny nicks in the anterior capsule, in a circular pattern, eventually connecting all nicks to create a round, but somewhat ragged capsulorhexis. As with LC and VC, this technique can be performed on any cataract type (regardless of visibility), without capsular dye, and can be done quickly. A disadvantage of this technique is diminished

capsulotomy stability compared to CCC and risk of capsulotomy run-out when removing cortex, as hanging capsular tags are easy to aspirate.

VIII. Extending the main wound

A. After completing the capsulotomy, attention can then be turned to completion of the main wound.

B. The keratome blade is re-inserted into the anterior chamber through the previous incision. Maintaining the blade parallel to the iris plane, the keratome is then used to extend the internal opening of the wound from side to side, flaring the blade such that the internal opening will be several millimeters wider than the external opening. When extending/flaring the wound, maintain a neutral blade position, following the contour of the cornea.

IX. Hydrodissection

A. Place the tip of the cannula beneath the capsulotomy and gently inject saline until the lens is freely mobile within the bag. This can be performed with a 27 gauge cannula on a saline syringe or with the irrigating simcoe cannula. Saline hydrodissection can be augmented with gentle side-to-side rocking of the nucleus with the tip of the cannula. Be certain that the nucleus is freely mobile before attempting to elevate it into the anterior chamber.

X. Elevation of Nucleus into the Anterior Chamber

A. Once the nucleus is freely mobile, the sub-incisional nucleus can now be elevated. To achieve this, a cannula (either a viscoelastic cannula, an irrigating simcoe cannula, or a 27 gauge cannula on a saline syringe) is used to gently nudge the nucleus AWAY from the incision (toward 6:00, if wound is superior). This displaces the nucleus inferiorly, allowing the superior pole of the nucleus to be engaged and elevated more easily. After nudging the nucleus toward 6:00, angle the cannula tip so that it's nearly parallel to the main wound and very gently depress the superior iris (exercise caution not to depress with force as this can cause zonular dehiscence). This gentle downward pressure will usually cause the superior pole of the nucleus to "pop up". Inject viscoelastic *beneath* the superior pole to keep it elevated. The cannula tip is then used to engage the equator and dial the nucleus up out of the bag and into the anterior chamber*.

c. In patients with small pupils, dialing the nucleus into the anterior chamber can be a very challenging step. If very miotic or if the nucleus is large, it may be necessary to create multiple small iris sphincterotomies (using Vaness scissors). A bent needle cystotome or Sinskey hook can then be used to engage the center of the nucleus and gently draw it to one side or the other until an edge "pops up" above the iris plane. Once an edge is elevated, you can then proceed to dial the nucleus out of the bag as described above.

*Experienced surgeons sometimes deliver the nucleus directly from the bag without dialing the nucleus into the anterior chamber. In general, this technique should be reserved for smaller nuclei such as those in hypermature cataracts with liquefied cortex as this technique may carry higher risk of capsular compromise if performed with larger nuclei.

XI. Nucleus Delivery

A. Confirm that the sclerocorneal tunnel is complete, continuous, and wide enough for nuclear delivery. If needed, the wound should be widened with the keratome - avoid bringing the nucleus through a tight wound as this frequently leads to endothelial damage, iridodialysis, and/or wound stretching.

B. Nuclear delivery can be performed using many techniques - hydroexpression, viscoexpression, direct mechanical delivery with a lens loop, or some combination of these techniques (irrigating vectis). We tend to use either the Simcoe cannula, the viscoelastic cannula, or the vectis, depending on the situation.

   a. Nucleus delivery with Simcoe cannula (hydroexpression) - Once the nucleus has been dialed into the anterior chamber, the tip of the Simcoe cannula is gently passed beside and then swept beneath the nucleus. The flow of irrigation in the anterior chamber causes the nucleus to move toward the funnel-shaped sclerocorneal wound. With the nucleus positioned in the funnel there is some build up of hydrostatic pressure behind the nucleus. Gentle downward pressure on the posterior lip of the wound with the heel of the Simcoe cannula, leverages this pressure gradient, allowing delivery of the nucleus. Some Simcoe cannulas have a serrated top surface which offers improved “grip” on the nucleus, augmenting nuclear expression.

   b. Nucleus delivery with viscoelastic cannula (viscoexpression) Deepak Khadka Video - Alternatively, a viscoelastic cannula can be used to perform a similar maneuver. The tip of the viscoelastic cannula is gently passed beside and then swept beneath the nucleus. A modest amount of viscoelastic is injected, causing the nucleus to move toward the funneled wound. As described above, gentle downward pressure on the posterior lip of the wound with the cannula allows delivery of the nucleus.

   c. Nucleus delivery with vectis (video 1:34) (mechanical delivery) - A vectis may be irrigating or non-irrigating, serrated or non-serrated. When using a vectis, we tend to use the serrated, non-irrigating variety, but others also work well. After the lens is dialed into the anterior chamber, a modest amount of viscoelastic is injected beneath the nucleus to keep it elevated and to push back the iris and capsule. The vectis is carefully inserted directly beneath the nucleus. Once in this position, the same downward pressure maneuver described above is used to deliver the nucleus. It is important to note that while

downward pressure is being applied with the heel of the vectis, the tip should not be rotated up as this can scrape the nucleus against the cornea causing endothelial trauma.

XII. Cortical removal

A. After nuclear expression, attention is turned to cortical removal. While irrigation and aspiration of cortex tends to be one of the most straightforward and safest steps of phacoemulsification, this step can be challenging and risky during SICS, especially when visibility is poor or the capsulotomy unstable. Care must be taken to ensure the capsule remains intact during this step.

B. The approach to cortical removal will differ depending on the type of cataract. Generally, the more mature the cataract, the less cortical material there will be and the easier it is to aspirate. In hypermature cataracts, you may find a solid nucleus floating in a capsule full of milky, liquefied cortex. This liquefied cortex may require only irrigation and no aspiration at all. Conversely, less mature cataracts often have extensive, sticky cortex which adheres tightly to the capsular bag, requiring caution and patience for safe aspiration. Complete aspiration is important as this cortical material will hydrate and become visually significant if left near the visual axis. It can also induce significant inflammation if left behind.

   a. The first step to cortical removal is hydroexpression of loose cortical debris. (1:44) Assuming the capsule is intact, the Simcoe cannula is opened to full flow and inserted into the anterior chamber. Gentle downward pressure on the posterior lip of the wound while irrigating creates a pressure gradient which flushes loose cortex out of the main wound. Gentle depression of the peripheral iris while irrigating will often free up a ring of cortical material which can then be flushed out.

   b. Any remaining cortex is then gently aspirated (1:50) with the Simcoe cannula. While aspirating, it is critical to keep an eye on the capsule, looking for any sign of traction. If the capsule becomes wrinkled or distorted, stop aspirating and get a new hold on the cortical material, free of any capsule. Caution is especially required when the capsulotomy is irregular (can-opener technique) or has a hinge (v-shape or linear capsulotomy technique), as loose tags and flaps are easily aspirated and can cause a capsular tear, destabilizing the bag. Simcoe cannulas should be periodically inspected to be sure there are no burrs or sharp edges as these can easily cause a capsular tear.

XIII. IOL insertion

A. If the capsular bag remains intact, this is then filled with viscoelastic. The IOL is grasped with toothless forceps (straight or bent) avoiding the center of the optic. The IOL is then advanced through the main wound, angling the leading haptic slightly downward to ensure in-the-bag placement. (2:50) Once the leading haptic is in the bag, and the armpit of the trailing haptic is resting at the edge of the

pupil, the IOL can then be released. At this point, you can either use the forceps to grasp the trailing haptic, dialing and dropping this into the bag, or you can use a lens dialer. The lens dialer is used to engage the armpit of the trailing haptic and dial the IOL into the bag using a clockwise motion. (3:00) The dialers best suited to this maneuver are those with a groove, which allows the haptic to remain engaged with the dialer, avoiding the annoying and potentially dangerous slippage which tends to occur with non-grooved lens dialers. Whether dialing the trailing haptic with forceps or a lens dialer, care should be taken not to place too much pressure on the bag, as this can cause a tear - especially when using PMMA IOLs, as the haptics are stiff.

XIV. Completion of Capsulotomy

A. If a linear or v-shaped capsulotomy has been employed, the next step is to complete the anterior capsulotomy. To complete the linear capsulotomy, vaness scissors are used to cut across one end of the capsulotomy, creating an "L" shape. The scissors are then used to create a parallel, partial cut across the opposite end of the original capsulotomy, creating a "U" shape. Then, while holding the partially cut capsule in the scissor tips, a gentle sweeping motion is employed, joining the two freshly made cuts, creating a complete anterior capsulotomy which has the shape of an open envelope. If the capsulotomy is not completed with this sweeping motion, the remaining flap can either be amputated at its base with the vaness scissors or "gripped" with gentle simcoe suction and swept around to complete the capsulotomy. (1:58)

B. If v-shaped capsulotomy has been performed, the hinge of the "V" is amputated with Vaness scissors to complete the capsulotomy

XV. Removal of viscoelastic

A. With the IOL securely in the bag and the capsulotomy completed (when applicable), any remaining viscoelastic can be flushed from the anterior chamber pressure on the posterior lip of the wound to facilitate fluid egress.

XVI. Anterior chamber formation and wound verification

A. After flushing all viscoelastic from the AC, the Simcoe cannula is held in the corner of the wound, allowing irrigation to enter the anterior chamber, but allowing little outflow. This causes the anterior chamber to form fully. Allowing the chamber to overfill slightly, until the eye is somewhat firm, verifies the stability of your wounds. Once wounds are confirmed to be watertight, excess fluid can then be released with a gentle tap on the wound edge, until IOP is physiologic. The accessory wound can be hydrated if any leaking is noted. The main wound can be sutured if necessary. Suturing the wound is *not* necessary and in fact not advisable if the wound is well constructed and holding pressure. Suturing can cause the the wound to close unevenly and actually promote leakage and irregular astigmatism, as well as infection. This is why a well-constructed wound is so critical to a good outcome.

XVII. Conjunctival Closure

A. If your main incision was created superiorly, no conjunctival closure is necessary. Gravity and the action of the eyelid naturally cause the conjunctiva to resume its anatomical position, allowing it to heal very quickly without sutures or other means of closure.

a. If you worked through a temporal wound, then conjunctival closure is needed. This can be accomplished either with cautery or a single suture reapposing the conjunctiva at the limbus.

b. Subconjunctival injection of broad spectrum antibiotics and steroid is then performed.

c. Drops of betadine are placed in the eye and irrigated with saline.

d. The traction suture (if used) and lid speculum are then removed and the patient is taken to post-op recovery area.