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Practicing making a scleral tunnel, using an apple in a digital dry lab. SOUTH AFRICA

Learning surgical skills for eye care

Advances in training methods and technology allow surgical teams to engage in sustained and deliberate practice, initially safely away from patients.


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Surgery plays a vital role in global eye care by addressing a wide range of eye conditions, from cataract to more complex eye diseases and injuries.

Our aim with this issue is to support the training and development of eye surgeons and surgical team members by sharing innovative, impactful, and proven ways to learn, practice, and teach surgical and technical skills.

Surgery used to be learnt only on patients, in accordance with the traditional approach of "see one, do one, teach one."[1] Advances in surgical simulation and the development of surgical competency rubrics have made it possible for surgeons to learn and practice in a systematic way, before operating on patients.

Competency assessment rubrics, such as the Ophthalmology Surgical Competency Assessment Rubrics (OSCARs),[2] divide surgical procedures into individual steps, each with four clearly defined grades: Novice, Beginner, Advanced Beginner, and Competent. Ophthalmic simulated surgical competency assessment rubrics (Sim-OSSCARs) have

About this issue

Surgery plays a vital role in global eye care by addressing a wide range of eye conditions, from cataract to more complex eye diseases and injuries. The aim of this issue is to support the training and development of eye surgeons and surgical teams, by sharing proven ways to learn, practice, and teach surgical and technical skills, including the use of competency assessment rubrics and simulation training. We also provide tips and guidance for scrub nurses/technicians. By practising together, in a simulated surgical set-up, teams can develop the communication and manual skills needed to improve surgical outcomes and protect patients.

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also been developed and validated for learning and practising surgical steps in simulation.[3,4]

The steps in competency assessment rubrics are demonstrated or taught one at a time. Trainees then practice each step, with appropriate supervision and feedback, until they are graded 'Competent.'

Another key building block for developing and enhancing surgical skills is **reflective learning**. Reflective learning is a continuous cycle that enables individuals to improve by critically evaluating their own performance against the criteria set in the relevant OSCAR or Sim-OSSCAR. It follows a cycle of practice, observation, error detection, trying a change in technique, and observing any differences in outcome.

Simulation training

Sustained deliberate practice – with or without feedback from mentors or trainers – is only possible thanks to the increasing availability of simulation training, where skills can be practiced away from patients.

Simulation training offers the surgeon an accessible, safe, and reproducible method of learning. Simulation training, also known as simulation-based surgical education, can be divided into four main types, in order of increasing cost:

1. Practice on foam sheets or fruit, with or without microscopes and microsurgical instruments
2. Practice on animal or human cadaver eyes (in a wet lab)
3. High-fidelity simulation, using artificial eyes.
4. Virtual reality (VR) simulation systems.

Simulation allows trainees to make mistakes and reflect without risking patient safety. Technological advances in virtual reality simulation can also provide practice in the management of complications, and surgical teams can practice handling these together. Advanced simulation technology may be a costly initial investment, and it is always worth exploring low-cost options to support training.[5]

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The surgical team

In this issue, we also provide tips and guidance for scrub nurses/technicians. By practising together in a simulated surgical set-up, nurses and surgeons can develop the communication and manual skills needed to improve surgical outcomes and protect patients – which includes practising the World Health Organization Safe Surgery check-in and check-out procedures.

All of this is not to say that the old adage of "see one, do one, teach one" has no value – far from it. Once surgeons and their teams have made the most of simulated training opportunities, they will gain vital – and essential – experience by observing experienced colleagues and practising under their supervision, provided that the patients they operate on have been carefully selected to ensure the operation is both safe for the patient, and a valuable learning opportunity for the surgeon and the surgical team.

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Van Charles Lansingh and Akshay Gopinathan Nair
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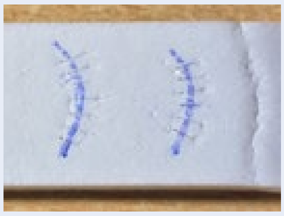
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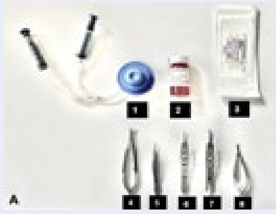
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Assisting during microsurgery: important first steps

Scrub nurses or technicians can prepare for their role by learning about instruments and instrument trays, learning the steps of procedures, and reviewing surgical procedures with the surgeons they will assist.

Learning about different surgical instruments and what they are used for is an important first step. CHILE

When it comes to assisting during microsurgery, there is much you can learn and practise before you enter the operating theatre.

1. Learn about surgical instruments and trays

The first step in learning to assist during microsurgery is to learn the names of the instruments and to become familiar with the different types of instrument trays.

A good place to start is in the sterilisation area, where instruments are reprocessed and packed for sterilisation in preparation for surgery. While you are in the sterilisation area:

- Use an ophthalmic instrument catalogue to identify the different instruments
- Use a magnifying glass to look at the fine tips of hooks or lens manipulators.

Each type of surgery or ophthalmic subspecialty (e.g. cataract, squint, cornea, oculoplastic) has a different instrument tray, containing the instruments the surgeon will need. Instruments on each of these trays are categorised into:

- Forceps and clamps (forceps can be toothed, smooth, serrated, or micro-notched; straight, curved, or angled)
- Scissors (sharp or blunt tips; straight, curved, or angled)
- Needle holders (locking or non-locking; straight or curved)
- Hooks, lens manipulators, retractors, and loops
- Cannulated instruments, e.g., Simcoe and anterior chamber cannulas
- Blade handles
- Speculums, calipers, or rulers.

Ask a senior colleague to show you what each instrument tray should look like. Take a photograph or draw the tray, then label each instrument. Ask your colleague to check everything is correct and in place.

Note

Ophthalmic microsurgical instruments are *very* delicate and have fine tips that need to be handled with great care.

Teaching tip
Create a photograph or drawing of each type of instrument tray and label each instrument with its name. Allow the trainee nurse or technician to arrange the trays accordingly, in preparation for sterilisation (Figure 1).

Figure 1 A nurse practices arranging microsurgical instruments on a tray before sterilisation. PERU

Figure 2 Nurses watch an operation being performed and note down the surgical steps, in order. PERU

2. Learn the steps of procedures

An excellent and safe way of preparing for a procedure is to learn the surgical steps and practise for them through simulation.

- Watch a video recording of the operation to be performed, or observe a live operation (Figure 2). Write down each surgical step and the instruments and supplies used. You can make a checklist, in table form (see Table 1).
- Next, arrange the surgical instruments on a simulated/mock 'sterile field' in the same order as the surgical steps (Figure 3).
- If you have a smartphone, take a photo of the setup to remind yourself of the sequence of steps.

Figure 3 Setting up surgical instruments in simulation.

3. Review procedures with the surgeon

A scrub nurse or technician may work with a different surgeon every day. It is helpful to set aside time to review the basic steps of the next day's surgical procedures with the surgeon, as this will help you to anticipate their needs more effectively.

I found it helpful to create a checklist, in table form, for the most common operations I'm likely to be involved in (Table 1), listing the surgical step, the type of consumable the surgeon may use, and the type of surgical instrument the surgeon may use.

Reviewing these steps with the surgeon may feel daunting at first, but you will become more confident the more you do it. When surgeons see that you are interested in being prepared, they will usually be happy to share this information, as it supports collaboration between surgeon and nurse, which can lead to better outcomes for patients.

Expert tip

I found it helpful to create basic checklists, in table form, for the most common operations I'm likely to be involved in. Table 1 shows an example of the table I created for small-incision cataract surgery (SICS). There is space to write note about the surgeon's preferences, such as the type of blade or suture they plan to use.

Table 1 A checklist summarising the steps of small-incision cataract surgery and the supplies and instruments needed.

Description of the step	Consumables/supplies	Surgical instrument
Placing speculum		Type:
Place bridal/stay suture	Suture:	Superior rectus forceps Needle holder Clamp
Dissect conjunctiva		Blunt curved Westcott scissors Non-toothed forceps
Cautery to blood vessels	Eraser tip:	Cautery cable/cautery forceps
First scleral incision	Blade:	Fine-toothed forceps
Scleral tunnel	Blade:	Fine-toothed forceps
Paracentesis	Blade:	Fine-toothed forceps
Stain the anterior capsule	Vision blue/air bubble	
Flush with BSS	2cc syringe & 27G cannula	
Viscoelastic injection	Type:	
Main sclerocorneal incision	Blade:	Fine-toothed forceps
Capsulotomy	Cystotome	Capsulorhexis forceps
Placement of AC maintainer	AC maintainer	
Hydrodissection	2cc syringe 27G hydrodissection cannula	
Enlarge main incision	Blade:	Fine-toothed forceps
Remove nucleus		Vectus loop
Cortex removal	Simcoe and IV tubing 5 or 10cc syringe	
Viscoelastic	Type:	
Insertion of IOL	IOL:	McPherson forceps Holding & folding forceps
Dial the IOL in place		Sinsky hook
Remove viscoelastic	Simcoe and IV tubing 5 or 10cc syringe	
Hydrate wounds (BSS)	2cc syringe & 27G cannula	
Check wounds for leakage	Microsponge	
Close conjunctiva	Suture:	Cautery cable/cautery forceps
Subconjunctival injection	1cc syringe & 30G needle	
Remove bridal/stay suture		Scissors
Eyedrops/ointment		
Eye pad/eye shield		

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Assisting during microsurgery: tips for success

Knowing how to handle instruments and sharps safely, and pass them correctly during surgery, are some of the key skills scrub nurses/technicians must learn.

Simulation training is very helpful in practicing to pass instruments safely. Nurses can take turns to role play as the surgeon and scrub nurse/technician, and can experience what it is like for the surgeon to perform surgery while looking through the microscope or using magnifying loupes. These tips are equally useful for simulation training and surgical procedures.

A nurse sets up the sterile field in preparation for surgery. INDONESIA

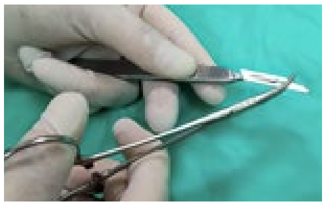
Figure 1 Passing a keratome blade to the surgeon (right) with the sharp end facing away from them.

Handling sharps safely

1 Hand over sharp instruments to the surgeon with the sharp end facing away from them (Figure 1). The surgeon may reach out their hand towards the sterile field and injure themselves if the sharp end is facing towards them.

2 When loading and removing blades from the Bard Parker blade handle, use a clamp (not your fingers), with the point of the blade facing in a downward position, away from yourself (Figure 4).

Figure 4 Using a clamp to remove a blade from the Bard Parker handle.



3 Never recap a needle. If you need to reuse a syringe, remove the needle from the syringe and replace it with a new needle. Remember: cystotome needles are also considered a sharp.

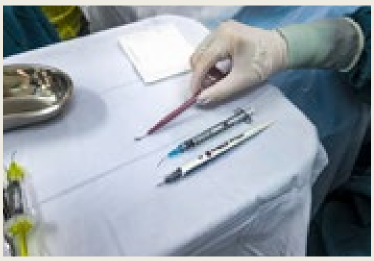
4 Be aware that a phacoemulsification tip/needle is sharp and should be covered by the plastic test chamber when not in use. It must be removed from the phacoemulsification handpiece before sending it for reprocessing.

Before you start

- **Ensure the surgeon is comfortable.** Before surgeons begin their pre-surgical handwash and don a sterile gown and gloves, ask them to check the position of the operating microscope in relation to the operating room table and surgical chair being used, and to check the position of the foot switches to ensure they are comfortable.
- **Ensure the patient is comfortable.** A comfortable patient is better able to cooperate during eye surgery. To keep patients comfortable during cataract surgery (if the eye drape doesn't have a fluid collecting bag), place a gauze swab at the side of the head to absorb fluid and prevent it from running into the patient's ear.
- **Find out whether the surgeon is right- or left-handed.** This will determine how you load sutures and pass instruments.
- **Agree how the surgeon will pass sharps back to the scrub nurse/technician after use.** The surgeon can say, "Sharp back" and place the used sharp in a receiver provided by the scrub nurse/technician (Figure 2), or place the sharp on the sterile field in an area designated only for sharps, known as the 'neutral zone' (Figure 3).

Figure 2 Surgeon placing sharp in a receiver held by the surgical nurse or technician.

Figure 3 Surgeon returning a blade to the neutral zone on the sterile field.



Passing instruments

1 When assisting the surgeon, it is good practice for the scrub nurse or technician to position themselves diagonally across from the surgeon, allowing them to pass instruments safely and comfortably (Figure 5).

Figure 5 The scrub nurse/technician is positioned diagonally across from the surgeon. Passing instruments correctly allows the surgeon to work without having to stop looking through the microscope.

2 All surgical instruments have a section on the instrument handle where the surgeon's fingers will hold or grasp the instrument (Figure 6). When passing an instrument to the surgeon, the scrub nurse/tech must ensure that their fingers do not obscure

Figure 6 The grip section on the instrument handle has ridges or holes that allow surgeons to grasp them securely. VIETNAM

this area, as this would make it difficult for the surgeon to grip the instrument (Figure 7).

3 Place the instrument in the hands of the surgeon at the correct angle and position (as if they are using a pen or pencil), so that the instrument can be used immediately, without the need to adjust it.

Figure 7 The scrub nurse/technician (left) passes the instrument to the surgeon (right). The scrub nurse/technician's fingers do not obscure the grip section of the instrument, which allows the surgeon to grasp the instrument in the correct position. **VIETNAM**

4 When the surgeon is looking through the microscope, pass the instrument so that the grip section of the instrument touches either the thumb and/or index finger; this allows the surgeon to feel when the instrument can be grasped. A surgeon who is using magnifying loupes, e.g., during strabismus or oculoplastic surgery, will have limited peripheral vision and will also rely on the scrub nurse/technician to place the instruments in their hands, ready for use.

5 Remember to make appropriate adjustments for left-handed surgeons.

Other best practices and considerations when assisting a surgeon during surgery

1 All medications drawn up and on the sterile field need to be labeled. Tell the surgeon the type of medication and dose when passing it to them.

2 All instruments which have been used during the administration of a cytotoxic agent, such as mitomycin C or 5-FU, must be placed in an area separate from the instruments that will be used to complete the operation. At the end of the procedure, these instruments can be rinsed with sterile water. Reprocessing is the same as for other instruments. The blades, needles and pledgetts used during the surgery must be placed in a sharps container labeled 'Cytotoxic.'

3 Wipe instruments immediately after use using a soft lint-free cloth. Blood, debris and viscoelastic should not be allowed to dry on the instruments (Figure 8).

Figure 8 The scrub nurse/technician wipes surgical instruments after use with a soft lint-free wipe. **VIETNAM**

4 When loading a suture, ensure you use the tip of the needle holder to grip the needle. Avoid loading the suture close to the sharp point or swage (the connection point of the suture and the needle). See **www.cehjournal.org/article/passing-sutures**.

5 If a suture is missing at the time of the WHO Safe Surgery Sign Out (see panel), the surgeon must inspect the wound, confirm that the suture needle is not in the wound, and sign the intraoperative notes.

6 There are different methods for loading intraocular lenses, depending on the brand and packaging. Before loading the lens, flush the optic with balanced salt solution (BSS) and fill the cartridge with viscoelastic. Avoid using fingertips to touch the intraocular lens.

7 Always have gauze, micro sponges and/or cotton tips readily available, and in reach of the surgeon, for soaking up blood or fluids from the wound.

8 All cannulated instruments and cannulas should be primed before use to prevent air bubbles entering the eye. When priming cannulas, hold your hand or a gauze swab around the tip of the cannula to prevent the solution from being sprayed into the air or into the eyes of a surgical team member. Using Luer lock syringes will prevent cannulas and needles from shooting off the syringe when under pressure.

9 Use sterile water to rinse or wipe instruments during surgery and as soon as the surgeon returns the instrument to the neutral zone or container. **Do not use saline or balanced salt solution (BSS) to rinse instruments, as this is harmful to the instruments.** At the end of the procedure, flush cannulated instruments with sterile water on the surgical field before sending them for reprocessing.

10 Remove any damaged instruments and set them aside in a designated area. This will avoid the frustration of a damaged instrument being reprocessed and ending up back in the instrument tray for another operation.

Complete the World Health Organization (WHO) Safe Surgery 'Time Out' checklist.

The surgical team must stop and check the following before starting the operation:

- The type of implant, if applicable (if an intraocular lens is planned, confirm the specific power of the lens, whether it is in the operating theatre, and whether a spare is available)
- The specific equipment needed
- Whether the instruments are sterile
- An initial count of the number of surgical instruments and consumables on the surgical field, including: suture needles, sharps (blades, hypodermic needles), retractors, pledgetts (used in glaucoma surgery), trocars and scleral plugs (used in retinal surgery), and sponges or gauze (used in oculoplastic surgery)
- Any anticipated issues or concerns that may arise during surgery, and what equipment, instruments and consumables must be available on standby
- Has the surgeon notified the surgical team of any non-routine steps?

After surgery, a final count of all the surgical instruments and consumables needs to be done for the 'Sign Out' section of the WHO Safe Site Surgery Checklist. The count needs to be confirmed with the surgical team and any discrepancies must be documented in the intraoperative notes.

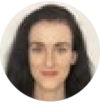
Table 1 The World Health Organization 'Time Out' checklist, adapted for eye surgery.

Intraocular implants ☐ Yes ☐ No **If IOL: Surgeon to confirm** ☐ Intraocular lens power and type **If Other:** (e.g. CTR, glaucoma tube etc) **OR nurse to confirm:** ☐ Chosen implant available
Surgeon to confirm: ☐ Specific equipment requirements ☐ Non routine steps the team should know
Scrub nurse to confirm: ☐ Sterility of the instrumentation confirmed (including indicator results) ☐ Specific issues or concerns addressed ☐ Initial count conducted

Table 2 The 'Sign Out' section used on the Orbis Flying Eye Hospital.

Surgeon / OR Nurse verbally confirms with the team: ☐ Count is complete ☐ Specimens / cultures ☐ Labeled with patient identifiers ☐ Equipment problems identified *If yes, please detail separately*

Basic microsurgical skills: suturing



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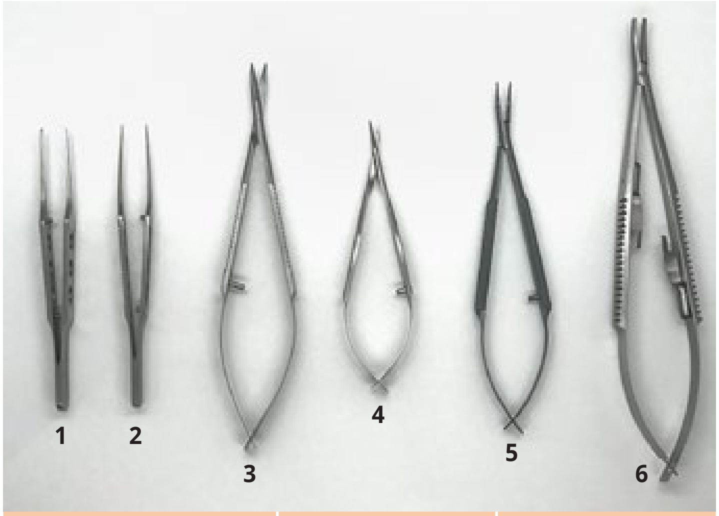
Operating under magnification is a challenging but vital skill that all ophthalmologists must develop.

From repairing an open globe, to suturing a rectus muscle, or closing a trabeculectomy flap, basic suturing using a microscope (or loupes) is an essential skill.

The tools of microsurgery

Since ocular tissues are so delicate, it is important to use instruments safely and to select the correct instrument for each task (Figure 1). For example, toothed forceps are designed for grasping tissue, while non-toothed forceps have a tying platform that enables the surgeon to grip suture material.

Figure 1 A basic set of instruments used for ophthalmic microsuturing. From left to right: St Martin forceps, suture tying forceps, Westcott curved scissors, Vannas straight scissors, Barraquer needle holders, and Castroviejo needle holders.



Instrument		Features	Example of use
1	**St Martin forceps**	Fine-toothed (micro-notched) tip	Gripping corneal tissue
2	**Suture tying forceps**	Flat tying platform	Handling suture material
3	**Westcott curved scissors**	Rounded, with blunt tips	Conjunctival peritomy
4	**Vannas straight scissors**	Fine, with sharp tips	Cutting corneal sutures
5	**Barraquer needle holders**	Round handle	Holding 10/0 suture needle for corneal sutures
6	**Castroviejo needle holders**	Flat handle, locking	Skin suturing

Figure 2 Hold surgical instruments as you would hold a pen or pencil.

Instruments are usually held as a pen would be (Figure 2). Fine movements are made using the fingers and wrist, with the hand resting to stabilise the motion.[1]

Sutures vary by needle type and suture material. Choice of suture depends on the type of tissue, strength and duration of wound support required. There are absorbable and non-absorbable sutures, which may be monofilament or multifilament (braided). Common sutures include:

- Vicryl (polyglactin), an absorbable suture which provides tissue support for 21 days, but induces inflammation as it is absorbed by hydrolysis reaction
- Ethilon (nylon), a non-absorbable suture, which would need removal if no longer required to support wound healing
- Prolene (polypropylene), also a non-absorbable suture.

It is generally best to use the thinnest suture suitable to accomplish the task. For example, 10-0 is preferable for corneal suturing, 8-0 for conjunctival suturing, and 6-0 for skin or tarsal plate suturing and reattaching rectus muscles.

The type of suturing needle can vary as follows:

- By cross-section of the needle, which affects the cutting planes of the needle
- By curvature arc of the needle, with the 3/8 circle needle being most commonly used.

Corneal gluing

Occasionally, corneal gluing may be used as an alternative to suturing. However, avoid gluing if watertight closure cannot be achieved – suturing will be needed instead. Use a cyanoacrylate or fibrin glue.

Corneal suturing

Corneal suturing is a core microsurgical skill. In low- and middle-income countries, it is usually one of first types of microsurgical suturing skills many trainees will learn.

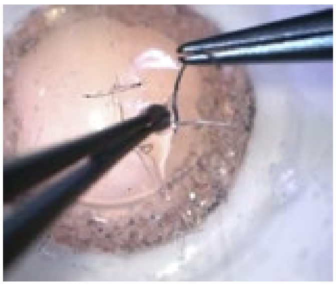
Corneal suturing is needed to repair traumatic corneal lacerations and, on occasion, cataract surgery incisions.

A 10/0 nylon suture is usually used for corneal suturing. The suture needle must be handled with care, as grasping the tip will blunt the needle, and grasping the swage may cause the suture material to detach from the needle. Further detail on the anatomy of the suture and handling the needle safely can be found in the article on passing sutures, in this issue.

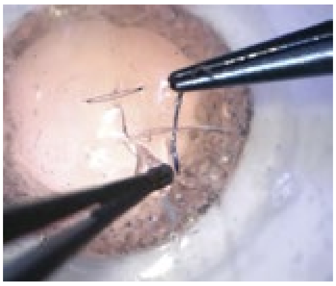
Interrupted sutures are the first type a trainee surgeon is likely to learn. The 3-1-1 technique described in Figure 3 produces a firm knot that is small enough to be buried by rotating the knot into the corneal tissue. This is more comfortable for the patient, and less likely to form a focus for infection. **Note:** when making more than one interrupted suture, ensure they are equally spaced and of equal length.

The images used to illustrate these steps were adapted from the video 'Repair of a corneal laceration' on **simulatedocularsurgery.com**,[1] and show a surgeon practising interrupted corneal suturing on an artificial eye.

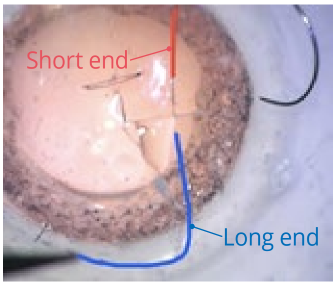
Figure 3 The 3-1-1 technique for interrupted sutures



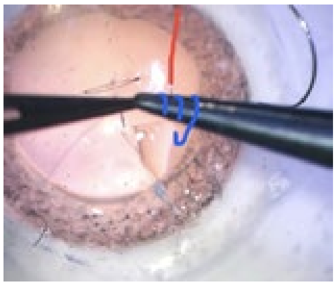
Step A
Using St Martins fine-toothed (micro-notched) forceps, evert the distal lip of the wound (the lip furthest away from the surgeon). Pass the needle from outside the wound to inside (at a stromal depth of two thirds) by rotating through the distal lip of the cornea. The needle should enter the cornea perpendicular to the corneal surface edge.



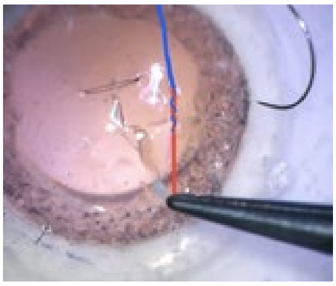
Step B
The needle should exit the cornea perpendicular to the corneal surface. To do this, gently grasp the proximal lip (nearest the surgeon) with the forceps. Push the needle into the proximal lip, directly opposite the exit from the distal lip, at an equivalent depth. Push and rotate the needle through the proximal lip, with gentle pressure on the lip to assist, then pull and rotate the needle once it is through the tissue, without touching the tip.



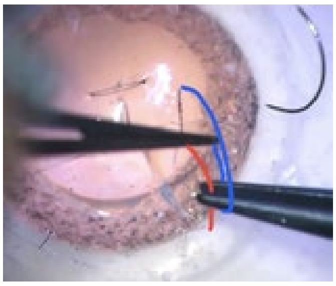
Step C
The suture should now be perpendicular to the wound, with entry and exit points equally spaced. To enable you to tie a secure knot, pull most of the length of the suture through the tissue, leaving a short end (highlighted in red in the image) and a long end (highlighted in blue).



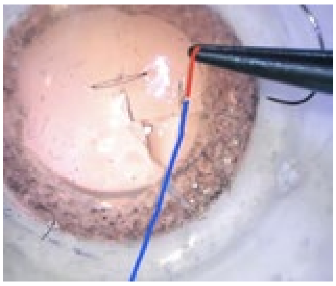
Step D
Holding the long end (blue) with tying forceps at a short distance from the cornea, wrap the long end around the needle holder three times. With these three loops on the needle holder, grasp the short end of the suture (red), on the opposite side of the wound.



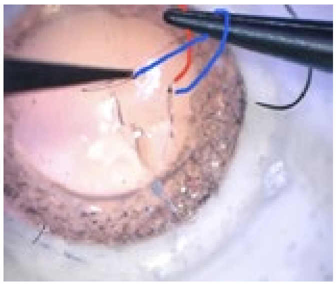
Step E
Pull the short end through the three loops and pull it down snugly towards the wound. This should have enough tension to bring the two wound edges together, without distorting the tissue.



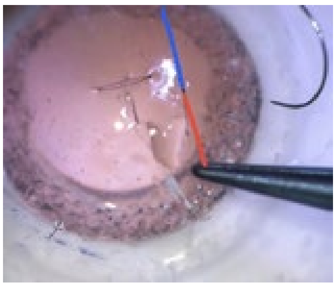
Step F
Next, loop the long end of the suture once around the needle holder, this time in the opposite direction (if the 3 loops were made wrapping towards yourself, then now wrap away from yourself).



Step G
Grasp the short end of the suture (red) and pull it through the single loop. Tighten this down snugly towards the wound to lock your suture in place.



Step H
Make one more single loop around the needle holder using the long end of the suture (blue), in the same direction as the first three loops (as shown in Step D), then grasp the short end (red).



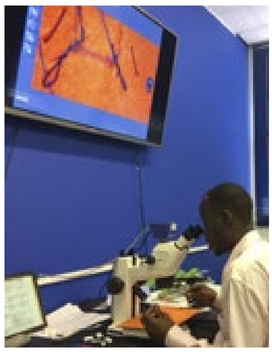
Step I
Pull both suture ends tight enough so that the two sides of the wound are well-opposed, but the tissue is not distorted.

Step J
Bury the knot by rotating the it into the corneal tissue. This is much more comfortable for the patient, and less likely to form a focus for infection.

Practice, practice, practice

Each of these steps can be perfected in a simulated environment, prior to operating on a patient. Operating microscopes or portable training microscopes may be used to practise corneal suturing (Figure 4).[2] Model eyes are available to practise these skills, but foam (even that used in the suture packaging) can also be a good medium to simulate corneal tissue. If a microscope is not available, the same suturing techniques can be practised on a larger scale using 7-0 sutures and the naked eye.

Figure 4 Ophthalmic trainees practicing suturing on foam sheets



Eyelid laceration repair can be performed without use of a microscope. Silicone suturing pads or fruit (such as banana peel) may be used to replicate eyelid tissue. The use of animal models has also been validated, for example Pfaff's use of a split pig head model to teach eyelid margin repair.[3] Guidance for practicing eyelid closure using simulation is also available on: **http://oculoplastics.info/video/thebasics/eyelid-margin-closure/**

Feedback

Simulation practice can be enhanced by peer or supervisor feedback, in addition to self-reflection using assessment rubrics. A useful tool called the Ophthalmic Simulated Surgical Competency Assessment Rubric (OSSCAR) has been created to assess various ophthalmic procedures, including corneal laceration repair.[4] By comparing their attempt to the assessment rubric, the trainee surgeon can identify areas for improvement. This may be augmented by video recording their practice sessions.

Beginning with simple linear corneal lacerations, the complexity of surgical techniques can be increased by creating irregular, shelved or stellate lacerations and by practising both right- and left-handed. Once interrupted sutures are mastered, trainees may progress to butterfly, purse-string or continuous sutures.

Useful videos

These videos all demonstrate a good technique for corneal suturing.

Corneal suturing, by Derek Ho
How to suture a corneal laceration, demonstrating 3-1-1 and slipknot techniques, on a model eye.
https://bit.ly/Corneal_Ho

How to suture a phaco incision, by Cataract Coach.com
Video of live surgery demonstrating how to suture a cataract surgery incision using a 10-0 nylon suture.
https://bit.ly/47bhmjL

Keys to Corneal Suturing, by Christopher J Rapuano
Video demonstrating key tips for corneal laceration repair, using a pig's eye.
https://bit.ly/3MKzAAr

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Developing the skills needed for successful manual small-incision cataract surgery


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Simulation training, preparation, and repeated practice of cataract surgical techniques will help you to become a confident and competent cataract surgeon.

Trainees practice cataract surgical skills on a goat's eye in the wet lab. INDIA

Cataract simulation training is a valuable part of the journey towards surgical competence. In this article, we suggest ways to:

- Prepare for hands-on surgical training
- Use simulation to learn and practice manual small-incision cataract surgery (MSICS)
- Select patients for your first 50–100 cataract operations.

We also share some tips and clinical pearls to improve your MSICS technique.

How to prepare for hands-on surgical training

- To ensure you are familiar with the **anatomy of the eye** and the **steps of the procedure**, study the wealth of material available in previous issues of this journal (**www.cehjournal.org**), online videos, and manuals of cataract surgery, and on websites such as Cybersight (www.cybersight.org).
- To develop an understanding of the **tools** of cataract surgery, practice safe handling of the equipment and surgical instruments, including the microscope.
- To better understand the **mechanics of cataract surgery**, observe senior surgeons performing cataract surgery. Pay attention to the different **approaches and surgical techniques**. Understanding the **surgical process** and **how the surgical team works**, will ensure both quality outcomes and patient safety.
- Participate in patient care to whatever degree your training allows; this will help you to develop **a professional attitude** towards patients and other eye care providers.

Learn manual small-incision cataract surgery (MSICS) using simulation

A randomised-controlled clinical trial showed that using synthetic eyes for simulation training in manual small-incision cataract surgery (MSICS) doubled the confidence of trainees and reduced complication rates by 72% when trainees operated on patients.[1] Similarly, a large-scale study in India showed a 52% reduction in posterior capsule rupture rates in procedures performed by trainees after they underwent skills training in the wet laboratory.[2]

A learning and teaching assessment rubric is a valuable tool for learning MSICS, and one has been specifically developed to guide practice of MSICS in simulation.[3] Virtual reality simulators provide a three-dimensional virtual, stereoscopic surgical guide for trainees to practice cataract surgical steps.[4] The MSICS simulators made by HelpMeSee and Orbis/FundamentalVR are discussed in two online-only articles in this issue – see **www.cehjournal.org**.

In a simulated environment, the basic steps of cataract surgery can be practiced individually – again and again – until the trainee is competent in that environment. The trainee should use the simulation environment to assess their own competence and confidence in each step, and – after honest reflection, or feedback from a trainer – focus their efforts where improvement is needed. Training overlays, that are available in virtual reality simulators, can be especially helpful. Displays of the depth of the dissection plane, intraocular pressure, blade angulation, adverse events, and error-indicators suggest deviations from accepted standards.

Artificial eyes are very useful for practicing scleral tunnels, corneal entry, capsulorrhexis, or capsulotomy, as well as intra-ocular lens (IOL) insertion. Apples provide an excellent and very affordable simulation medium that allows trainees to practice scleral tunnel formation using a crescent blade. Tomatoes and grapes are useful for simulating the practice of capsulorrhexis, and bovine, porcine, or goat eyes can help trainees to become familiar with the anatomy of the eye, and how it responds to interactions.

How to select patients for your first set of cataract operations

Case selection is vital for your initial 50–100 operations. Select only low-risk patients, as this will minimise the risk of poor patient outcomes. If possible, video record the operations you perform. Reflective learning is very powerful, and it is worth using an assessment tool to evaluate your performance.[5,6]

An ideal patient for cataract surgery by a novice trainee is described below.

- Good vision in the other eye (the one not being operated on).
- Good access to the eye (known as 'good ocular exposure'). Exclude patients with deep eye sockets, a large nasal bridge, and/or small eyes.
- Nuclear sclerosis of grades 2–3 (without posterior subcapsular cataract), with no evidence of potential zonular weakness.
- Pupillary dilation of at least 7 mm.
- A clear cornea and healthy endothelium.
- Normal axial length (22–24 mm)
- An absence of pre-existing ocular co-morbidities, including ocular trauma, glaucoma, shallow anterior chamber, pseudoexfoliation, uveitis, or posterior synechiae.
- Good general health, a mobile cervical spine, and the ability to lie still and flat for an extended period of time
- Someone whose language you, as the surgeon, can understand and speak.

Surgical tips

1. Stabilising the globe is essential for proper tunnel construction and nucleus delivery.
2. Adequate, but light cauterisation of the scleral blood vessel makes it easier to visualise the tunnel depth during scleral groove construction.
3. Marking the scleral incision with calipers helps with the exact placement of the incision and with good tunnel construction.
4. Constructing a slightly oversized scleral tunnel, with the inner opening larger than the outer opening, reduces risk during nucleus delivery.
5. Capsular staining improves visibility and control of the capsular tear during continuous curvilinear capsulorrhexis.
6. A 7.5 mm capsulorrhexis reduces the risk of nucleus entrapment in the capsular bag. Consider a linear or envelope capsulotomy.
7. To reduce the risk of anterior chamber collapse, maintain a slight upward force on the roof of the tunnel during capsulorrhexis, hydrodissection, hydrodislocation, and cortical cleanup.
8. Respond quickly to potential capsulorrhexis runout by pulling the apex of the flap towards the centre of the tear (the Brian Little rescue technique)[7] or by converting to a mini can-opener technique. To help prevent capsular run-out, use viscoelastic or ophthalmic viscosurgical devices or use an anterior chamber maintainer to increase pressure.
9. During hydrodissection, without pressing down on the nucleus, ensure the cannula is placed just below the capsulorrhexis margin at 3, 6, and at 9 o'clock.
10. Use ophthalmic viscosurgical devices above and below the nucleus during vectis delivery of the nucleus to protect the endothelium, iris, and posterior capsule.
11. Use the aspiration port of the Simcoe cannula to carefully engage and peel cortex off the capsular bag. This reduces stress on the zonules and enhances separation of the cortex from the capsule.
12. Ensure adequate flow of balanced saline during cortical cleanup. However, to reduce the risk of iris prolapse, avoid over-pressurising the anterior chamber.
13. Carefully control aspiration force and maintain the aspiration port in the upright position to reduce the risk of anterior chamber collapse and posterior capsular captures and tears.
14. Use an ophthalmic viscosurgical device to adequately fill the capsular bag before inserting the intraocular lens.
15. At the end of surgery, restore intraocular pressure and double check that it is adequate. A large, single air bubble after surgery is a sign that the anterior chamber is clear of viscoelastic or vitreous. Remove the bubble at the end of the operation.

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Vitreoretinal surgery: an introduction to simulation training

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Simulation training can support vitrectomy surgery trainees to develop their skills and build a strong foundation of knowledge and understanding.

Pars plana vitrectomy surgery requires a prolonged period of learning and mentorship and should not be performed without the necessary training and hands-on experience, some of which can be gained through simulation training. A virtual reality (VR) simulator, although expensive, can be a helpful tool for learning techniques; some, such as posterior hyaloid separation, is difficult to simulate in any other way. We recommend choosing a VR simulator that gives direct and immediate feedback and comes with multiple dexterity and navigation modules.

In the absence of a VR simulator, it is still possible to practise vitrectomy skills in more affordable ways.[1–3] It is important to practise in as realistic a setting as possible: in the operating room used for retinal surgery and while using the operating microscope with indirect viewing system, the operating chair and microscope foot pedal, and resterilised retinal instruments.

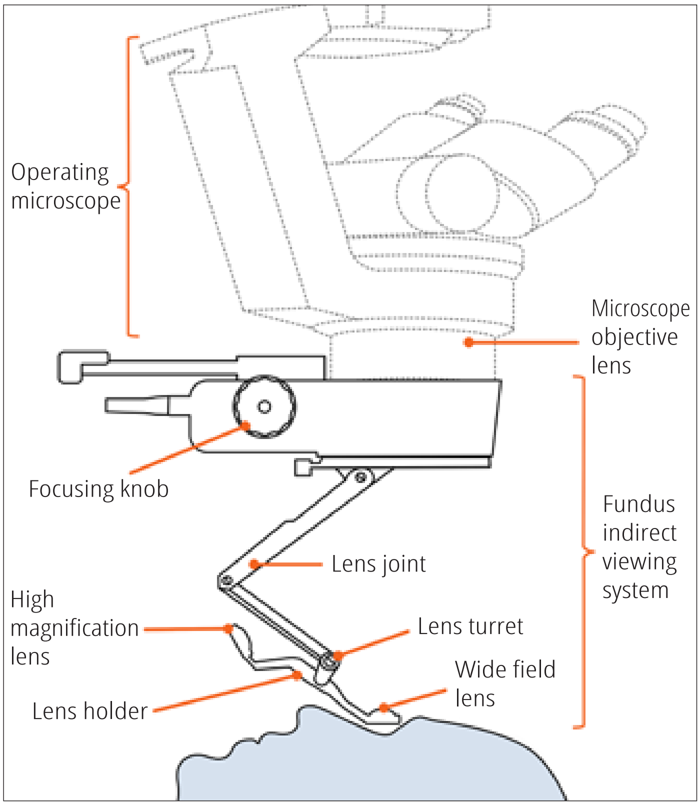


Figure 1 An indirect viewing system with automated inverter in the microscope.

The indirect viewing system

Vitrectomy is performed using an indirect viewing system (Figure 1). This generates a wide-field, inverted view of the retina which is corrected with a prism inverter.

How to use the indirect viewing system

Use the microscope controls to move the indirect viewing system closer to or further away from the eye. This controls the field of view. The closer the lens is to the cornea, the wider the field of view. The lens should be about 5–10 mm from the cornea. If it is too close, the lens may steam up. If it touches the cornea, it needs to be wiped dry.

To focus the image, rotate the focusing knob or dial on the indirect viewing system to alter the distance between its lenses. More advanced systems have electronics attached to the foot switch which can control this.

Figure 2a A simple model for practising tasks and navigation.

Figure 2b Model eye for practising navigation during simulated vitrectomy surgery.

Note: viewing the retina through the indirect viewing system is very sensitive to eye rotation during surgery. Learn to instinctively adjust the microscope's X-Y joystick as you rotate the eye to view different parts of the retina. Move the microscope in the same direction as you rotate the eye, but be careful not to move too far or you will lose the optimal view.

Tools for learning & practicing

1. Navigation, with rotation of the eye to view different parts of the retina

To practice navigation, we recommend making the simple model described in a previous issue of this journal (Figure 2a)[1] but make the pupil diameter very small, as shown in Figure 2b. This helps to simulate the dexterity needed to maintain the view during eye rotation, as it requires very accurate microscope adjustments to maintain the view.

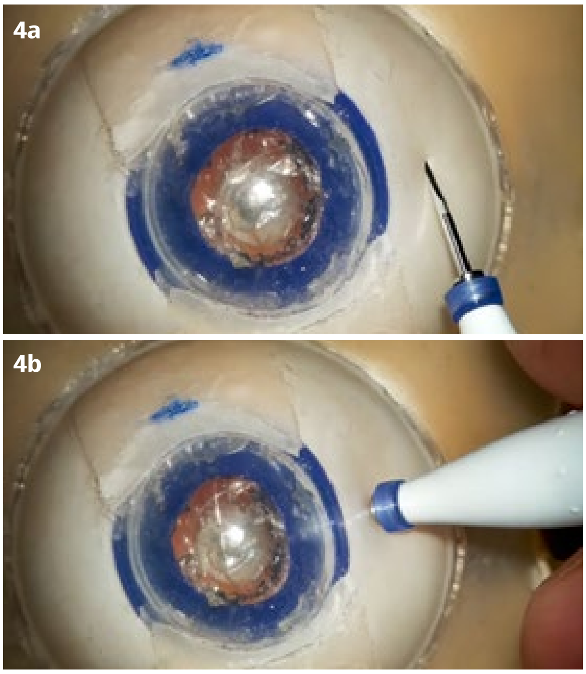
2. Trocar insertion and infusion placement

Practise the following on soft silicone eyes. To keep costs in check, we work on eyes previously used for cataract surgery simulation.

- Measuring the position for inserting the trocars (Figure 3)
- The two-step angled (or bevelled) insertion of trocars (Figures 4b and 4c)
- Attachment of the infusion line.

Figure 3 Measuring the position for insertion of the trocar.

Figures 4a and 4b Two-step angled (or bevelled) insertion of the trocar.

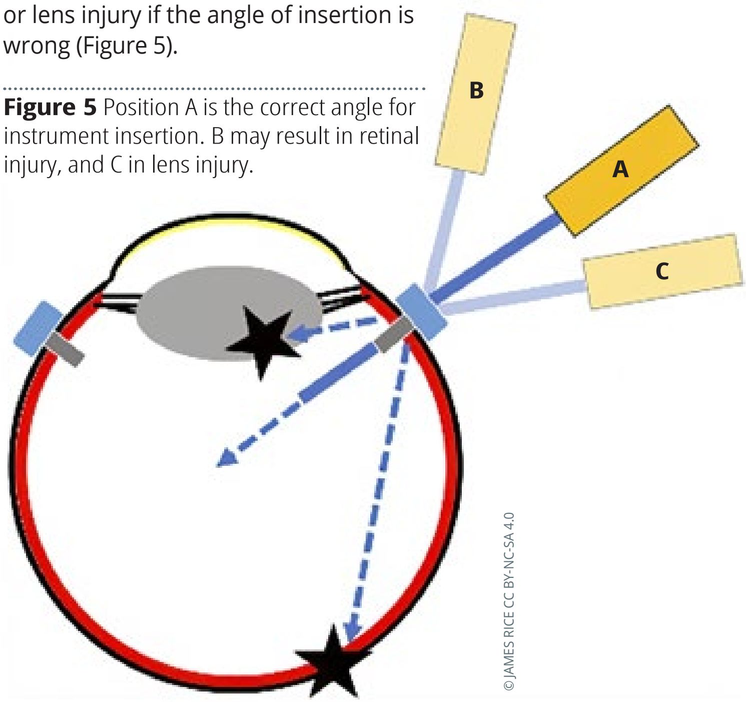


3. Instrument insertion

Practice instrument insertion, usually with the vitrectomy probe and light pipe, while being aware of the correct angle or direction of insertion.

Warning: this process may result in retinal injury or lens injury if the angle of insertion is wrong (Figure 5).

Figure 5 Position A is the correct angle for instrument insertion. B may result in retinal injury, and C in lens injury.



4. Core vitrectomy and air fluid exchange

We practice core vitrectomy on specially designed artificial eyes, which we fill with egg white and 'stain' with triamcinolone acetonide. In the absence of a posterior segment machine, we use a 23-gauge anterior vitrectomy handpiece from the phaco machine and a separate light box. By adding a 3-way tap and an air pump (a fish tank pump) we can practice core vitrectomy, blue dye stain of the epiretinal membrane, epiretinal membrane peel, air fluid exchange, and simulated gas injection. See Figure 6.

Figure 6 Infusion setup for air-fluid exchange.

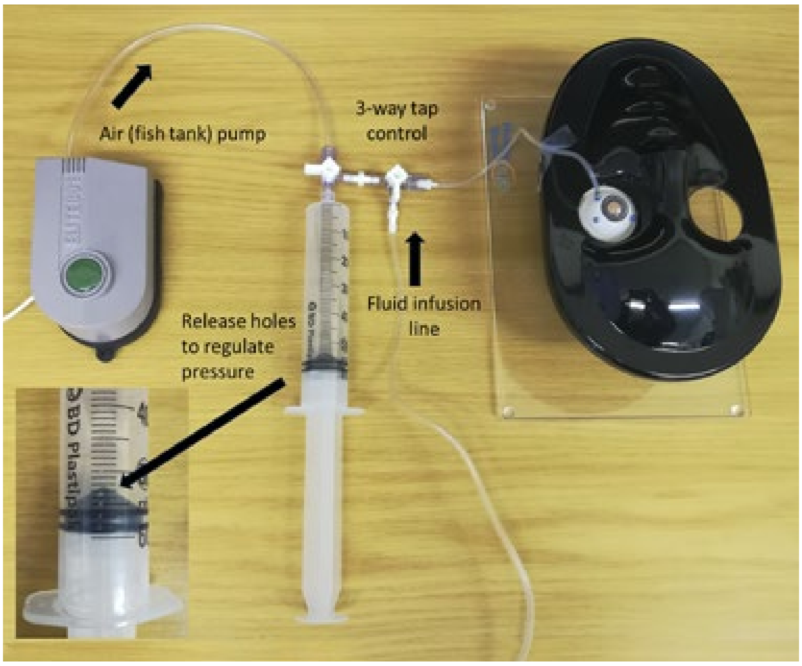


Figure 7 Mounting of a modified artificial eye, so it can be used for practicing indentation.

5. Indentation techniques

We recommend using a compressible artificial eye supported on a screw at the posterior pole which allows free rotation (Figure 7). This is useful for practicing a direct view of the indent (through the microscope only, Figure 8a) and an indirect view (through the indirect viewing system) (Figure 8b). You can also practice indented, 'shaving' manoeuvres if a chandelier light is available.

6. Dexterity tasks

It is helpful to learn to use retinal instruments by performing delicate manoeuvres under the indirect viewing system. You can practice these manoeuvres on affordable plastic eyes. Use real retinal forceps and scissors of various designs to become familiar with their squeezing action and practice bimanual techniques, which are usually the most challenging. Refer to the model described in a previous issue of this journal.[1]

Tips for training others

Trainees should be taught how to set up a vitrectomy machine, as they may not have a skilled nurse to assist. They should also have an understanding of the effects of different settings. For example, a low cut rate removes the core vitreous more quickly than a high cut rate, but a high cut rate is safer when working near the retina. The different models of machines have significantly different settings and capabilities, and trainees need to be familiar with the machine they will use.

> **"We recommend breaking vitrectomy surgery into individual surgical steps. Teach trainees details of the relevant ocular anatomy and pathology relevant to each step."**

We recommend breaking vitrectomy surgery into individual surgical steps. Teach trainees details of the relevant ocular anatomy and pathology relevant to each step. Discuss surgical instrument design, handling, and the goals of the step, so that trainees have a detailed understanding of how to perform it accurately. Then demonstrate the step a few times, while giving a detailed explanation. Trainees should then perform the step and explain their actions. This is followed by sustained, deliberate practice, performing the step repeatedly. Trainers should observe and give feedback.

We provide trainees with written, descriptive guidelines for each step, which they refer to as they practice. Structured feedback and assessment tools, such as the Ophthalmology Surgical Competency Assessment Rubric for Vitrectomy,[4] are available for live vitrectomy surgery. They are not fully transferrable to the simulation lab, but we still find them useful.[4]

Next, trainees should combine the steps to perform more complete procedures on a virtual reality simulator or on plastic eyes, as described above. Observe and give feedback and encourage the trainees to reflect on their performance. If video equipment is available, trainees should record and critically review their performance, preferably with the trainer.

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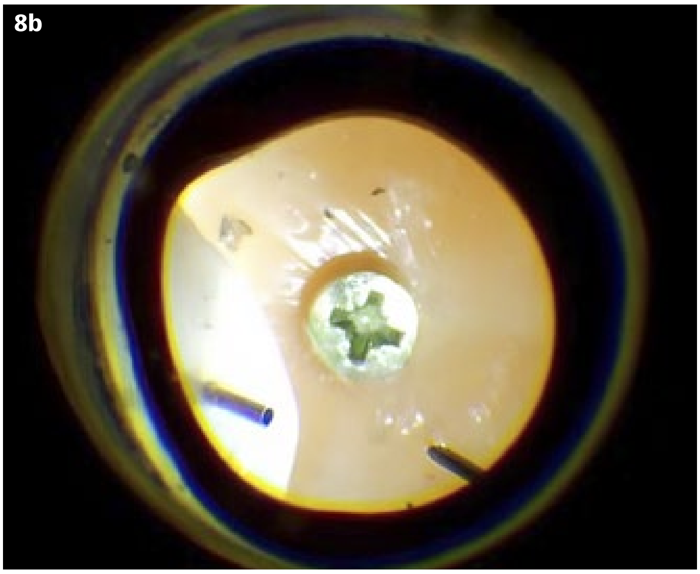
Figures 8a and 8b Direct view (a) and indirect view (b) of simulated, indented peripheral retina.



Passing sutures

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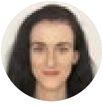

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It is important to load sutures correctly before passing them to the surgeon. Pay attention to where and how you grip the needle, and be aware that a different position may be needed for left-handed surgeons.

Most sutures used in ophthalmic surgery are loaded onto curved needles, which should always be passed with the sharp tip and swage curving up, towards the ceiling.

Ask the surgeon ahead of time how they would like their needle to be loaded (or held) in the needle holder. Also, check whether they are right-handed or left-handed.

Forehand or backhand pass?

Most surgeons prefer to make **forehand** suture passes, working from the side of their dominant hand **towards the centre** of the operating field. For a right-handed surgeon, the needle tip must point to the left, and for a left-handed surgeon, it must point to the right.

Ask the surgeon to tell you if they want to make a **backhand** suture pass, i.e., working **away from the centre** of the operating field. A backhand pass for a right-handed surgeon would be loaded in the same orientation as a forehand pass for a left-handed surgeon, and vice versa.

Loading the needle holder

You will need:

- A needle holder (also known as a needle driver)
- The suture needle, with a suture attached to it
- A second instrument, such as tying forceps

Steps

1 Use the second instrument, such as tying forceps, to pick up the needle. Note: **Do not touch the needle with your hands**, even when wearing gloves. This will help to avoid injury.

2 Open the needle holder. Use the **tip** of the needle holder to grip the needle **just to the rear of the centre of the needle**; in other words, slightly closer to the swage than to the tip of the needle. Figures 1 and 2 show the correct position when loading a suture needle for a right-handed surgeon making a forehand pass; Figure 3 is the position for a left-handed surgeon.

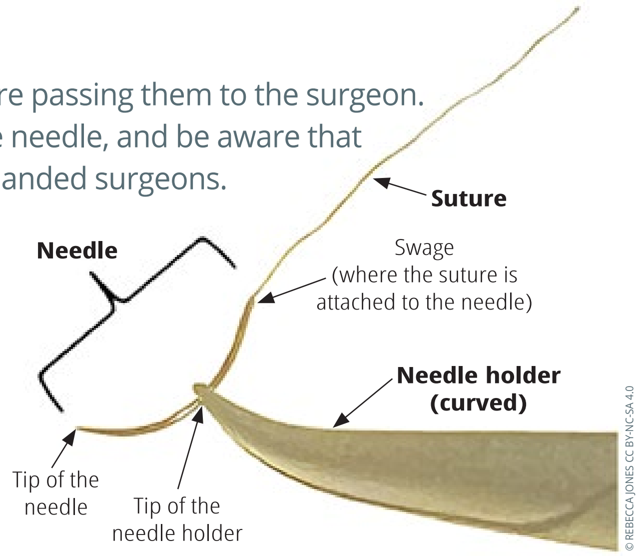

Figure 1 The suture needle, suture, and needle holder. The centre or body of the needle is gripped by the tip of the needle holder. The surgeon is right-handed, so the sharp point of the needle faces to the left.

Figure 2 Suture needle gripped correctly for a **forehand pass** by **right-handed** surgeon.

Figure 3 Suture needle gripped correctly for a **forehand pass** by **left-handed** surgeon.

3 Grasp the needle holder in the centre and pass to the surgeon.

Using a curved needle holder

Curved needle holders have a tip that is curved (or bent) to one side; this allows the surgeon more room to manipulate the suturing needle, without the needle holder getting in the way. To grip a suturing needle using a curved needle holder, rotate the needle holder so that the tip bends, or curves, in the direction of the swage (see Figures 2 and 3).

Tips

- Avoid gripping the needle close to its point, otherwise the surgeon will not be able to insert the needle deeply enough into the tissue. You may also blunt the sharp needle tip.
- Avoid gripping the needle close to the swage, because you may damage the needle and dislodge the suture.

This YouTube video has useful practical tips: bit.ly/CEHJ-suture

Picture quiz

Spot the error(s), if any, in these images. Say what is wrong in each case (select as many options as needed).

1. Suture ready for forehand pass for right-handed surgeon

Select as many options as needed:
a. Everything is correct.
b. The wrong part of the needle is being gripped
c. The wrong part of the needle holder is used
d. The needle faces the wrong direction
e. The tip of the needle holder is curved/bent in the wrong direction, relative to the needle.

2. Suture ready for forehand pass for left-handed surgeon

Select as many options as needed:
a. Everything is correct.
b. The wrong part of the needle is being gripped
c. The wrong part of the needle holder is used
d. The needle faces the wrong direction
e. The tip of the needle holder is curved/bent in the wrong direction, relative to the needle.

3. Suture ready for forehand pass for right-handed surgeon

Select as many options as needed:
a. Everything is correct.
b. The wrong part of the needle is being gripped
c. The wrong part of the needle holder is used
d. The needle faces the wrong direction
e. The tip of the needle holder is curved/bent in the wrong direction, relative to the needle.

4. Suture ready for forehand pass for left-handed surgeon

Select as many options as needed:
a. Everything is correct.
b. The wrong part of the needle is being gripped
c. The wrong part of the needle holder is used
d. The needle faces the wrong direction
e. The tip of the needle holder is curved/bent in the wrong direction, relative to the needle.

ANSWERS

1 b. The needle is gripped too close to the point.
2. c, d, e. The tip of the needle holder should not curve/bend in the direction of the tip of the needle – it should curve/bend towards the swage.
3. d. The image is correct for a left-handed surgeon making a forehand pass. For a right-handed surgeon, the needle must point to the left, and the concave curve of the tip of the needle holder must curve to the right.
4. b. The needle is being gripped too close to the swage.

Phacoemulsification cataract surgery: what you need to know

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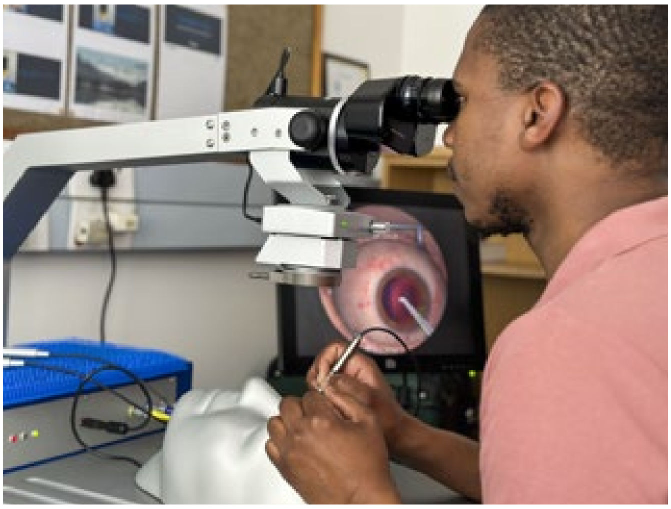
The need for phaco is increasing – especially for those patients with less mature cataracts.



Phaco training using a high-fidelity simulator. SOUTH AFRICA

Setting up a phacoemulsification (phaco) cataract service from the ground up can be daunting, as it requires suitable equipment and preparation. Ensure your facility is prepared to handle phaco surgery with properly maintained equipment, adequate supplies of phaco cassettes and consumables, ophthalmic viscosurgical devices (OVD), specialised phaco instruments, and an adequate microscope with an excellent coaxial illumination source.

There are also several considerations beyond the training of surgeons and teams. Biometry will be essential, along with a reliable supply of foldable IOLs across a whole range of powers. Supplies are more expensive than those needed for manual small-incision cataract surgery (MSICS), and these will need to be budgeted for. The equipment will need regular maintenance, and personnel will need to know how to troubleshoot in case of problems. A voltage stabiliser and uninterruptable power supply will be needed if electrical supply is unreliable at your facility. Is there vitreo retinal support available from surgeons in the area, in case of a dropped nucleus? Speak to colleagues for advice.

How to practice skills for phaco using simulation

Learn the basics of phacodynamics and fluidics by reading standard manuals and visiting websites (listed below in 'Useful training resources'). Remember that there is a steep learning curve. Learn the feel of the phaco foot pedal while listening to the sounds of the machine in various pedal positions and sampling other functions you may need. Familiarise yourself with the settings on the machine (phaco power, vacuum, aspiration rate).

Before operating on live patients, surgeons learning phaco must undergo simulation training (on animal or artificial eyes) in as realistic an operating theatre environment as possible. Practice finger positioning on the large handpiece, hand positioning to manage the weight of the handpiece, and foot pedal activation until you can control the handpiece easily and intuitively.

Virtual reality (VR) simulation training in phacoemulsification is also possible using the training modules available with the Eyesi® surgical simulator, which has been shown to reduce complication rates in operations performed by trainee surgeons by up to 38%.[1] The Eyesi® is especially useful for practicing capsulorrhexis. Any virtual reality or other simulation training must always be supported by live surgical observation as well as supervised practice.

Useful training resources

The PGY2, PGY3 and PGY4 Residents' videos on cataractcoach.com are an excellent resouce: **https://cataractcoach.com/2020/01/25/list-of-key-videos-for-residents/**

Orbis International's Cybersight website has a 'Fundamentals of Phacoemulsification' course: **https://cybersight.org/online-learning/**

Sullivan P, Benjamin L, Little B. Phacoemulsification Surgery: An Interactive Multimedia Atlas for Ophthalmology Trainees. The PDF version is available from **https://bit.ly/46CBYjM** and an interactive version from the iBooks store.

Simulatedocularsurgery.com offers videos for practicing phaco cataract surgery: **https://simulatedocularsurgery.com/cataracts**

A longer version of this article is available at **www.cehjournal.org** *and on our app.*

From the field

The need for phaco

Hillary Rono is an ophthalmologist working in Kenya's Ministry of Health. He is also the Country Director of Peek Vision in Kenya.

"In Kenya, patients are increasingly demanding phacoemulsification (phaco) cataract surgery, partially due to its reputation for more rapid healing and better visual outcomes.

"Preliminary results from the Rapid Assessment of Avoidable Blindness (RAAB) survey study in Kenya show that existing cataract surgical services (using the Manual Small-Incision Cataract Surgery, or MSICS, technique) are reaching those who are blind or have severe visual impairment due to cataract. However, people with mild or moderate visual impairment due to cataract are not offered MSICS surgery, due to the risks associated with MSICS procedures in patients with less mature cataracts.

"To address this gap, there is a need for more surgeons to learn phaco surgery. It is important that surgeons retain their MSICS training, however, as it will be needed at various times in their practice, including when they encounter difficulties during phaco surgery."

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Maintaining high quality trichiasis surgery before and after trachoma elimination


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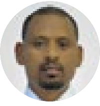
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Surgical simulation training can help to maintain the quality of trichiasis surgery in a post-elimination setting.

Trachoma, the world's leading infectious cause of blindness, is targeted for global elimination as a public health problem by 2030. The World Health Organization (WHO) criteria for elimination of trachoma as a public health problem are (i) a prevalence of trachomatous trichiasis (TT) unknown to the health system of <0.2% in adults aged ≥15 years and (ii) a prevalence of trachomatous inflammation—follicular (TF) in children aged 1–9 years of <5%, and (iii) evidence that the health system can continue to identify and manage incident cases of TT.[1]

Maintaining the quality of TT surgery – as countries approach and go beyond trachoma elimination – is complicated by the fact that surgeons are conducting fewer operations, which can result in declining surgical skills. Suboptimal surgical quality is not only bad for the patient, but also threatens the achievement of the global elimination of trachoma, as it increases the likelihood that TT will recur, thereby undermining community confidence in trachoma programmes. To maintain the quality of TT surgery, several programmatic activities have been recommended, including certification for surgeons, ongoing supportive supervision, surgeon audits, and refresher training.

Trichiasis surgery for trachoma,[2] the third edition of which will soon be published by WHO, provides a framework for certifying health workers in either bilamellar tarsal rotation or modified Trabut sugery for TT. In order to be certified to carry out TT surgery, health workers must:

1. Complete training in TT surgery in a course of accepted minimum depth and practical content (depending on national policy) and have conducted surgery on at least ten eyelids independently
2. Receive a recommendation for certification from an instructor
3. Successfully perform five sequential operations under observation by the certification examiner, with 'success' defined as fewer than 10 unsatisfactory marks on the certification checklist and none in critical areas.

Since the first edition of the WHO manual was published in 1993, it has been used by trainers as a training tool and by surgeons as a reference work, to increase the quality of surgery in settings where trachoma is endemic.

Surgical simulation

In many trachoma-endemic settings, HEAD START is being used to support trainee surgeons to build their skills and confidence before performing surgery on patients. HEAD START is a surgical simulator on which surgeons can practise surgical skills. The simulator is small and portable, allowing training to take place in remote settings. Previous research has demonstrated that simulation training with HEAD START prior to operating on patients reduces the number of times the trainer needs to intervene when the trainee makes an error and reduces the overall time required for surgery.[3] HEAD START is also used to provide refresher training and regular professional development for experienced surgeons.


A trainer demonstrates how to perform modified Trabut surgery on HEAD START. NIGER

Recent work shows that using HEAD START as part of refresher training for trichiasis surgeons also improves long-term surgical outcomes.[4] Other work also suggests that the use of HEAD START is readily accepted by surgeons and could be used during periods with low TT surgical activity (such as during the rainy season, when – in many settings – presentations decline).

In many countries, there are not enough trained eye care providers to deliver the surgical services needed to eliminate trachoma as a public health problem, or to ensure that high quality surgical services remain available in a post-elimination setting. HEAD START facilitates the training of general health workers to conduct TT surgery and has the potential to be integrated into tertiary eye health centres. Plans are currently in development to equip secondary and tertiary eye care units in Ethiopia with HEAD START to enable eye care workers to practise their skills. This is essential for the sustainability of programmes and for maximising the impact of limited resources.

The WHO World Report on Vision (**bit.ly/world-report-on-vision**) emphasises that people who need eye care must be able to receive high-quality interventions. The global trachoma programme provides examples of how continuous professional development systems, including certification and innovative training materials with supportive supervision, can improve the quality of outcomes. However, the trachoma community cannot become complacent. Achieving the elimination of trachoma as a public health problem makes it challenging to maintain quality in post-elimination settings. Doing so requires forward thinking to ensure that trachoma interventions, including training, supervision, and certification, are integrated into routine health systems.

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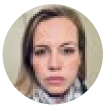

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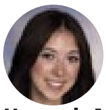

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Cybersight: improving remote access to surgical training and mentoring

Remote mentoring can provide affordable access to surgical training, even in low-resource settings.

Residents undergoing anterior segment simulation training onboard the Orbis Flying Eye Hospital, a form of training that was hampered by the COVID-19 pandemic. MONGOLIA

Cataract remains the leading cause of blindness, disproportionately affecting low- and middle-income countries.[1] As global populations continue to age, cataract-related vision impairment is projected to rise. A survey conducted in 2017 across twenty low- and middle-income countries revealed that only 36.7% of operable cataracts had been successfully treated.[2] To address this pressing issue, an increase in trained ophthalmologists is required to provide high-quality, accessible surgery.[3]

Regrettably, some ophthalmology residency programmes suffer a shortage of mentored, hands-on surgical training opportunities, while others offer no surgical training at all.[4] Recognising this disparity, Orbis has been making significant efforts, since 1982, to bring teaching physicians together with those in need of mentorship. However, the COVID-19 pandemic profoundly impacted hands-on surgical training models, such as hospital-based training, the Flying Eye Hospital, and face-to-face fellowships.

To continue supporting eye health professionals worldwide, Orbis has developed remote surgical mentorship models.

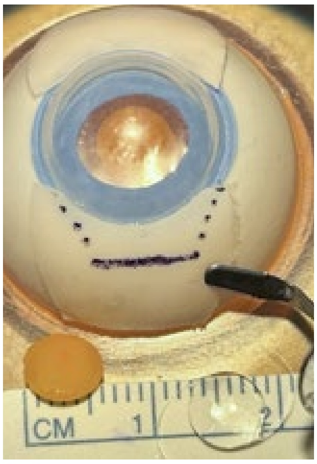
Remote mentoring in surgical skills is a method of professional development whereby an expert ophthalmologist uses live video and audio feedback to guide a less experienced ophthalmologist (or ophthalmology resident) during live or simulated surgery, regardless of their geographical distance from one another. Remote surgical mentorship offers unique advantages, including increased access to hands-on training and exposure to a diverse range of mentors using a range of different approaches. This can be challenging to achieve through traditional in-person mentoring.

Simulation training improves the hand-eye coordination of trainee surgeons before they transition into an actual operating room setting. It also has the potential to improve patient safety and enhance outcomes while also maximising the impact of scarce teaching resources. Improving trainees' access to simulation training is therefore critical for helping them to develop their skills in a safe environment, thereby reducing patient complications during their training.

It is possible to pay up to $20,000 USD for live surgical mentorship equipment and systems. In our experience, however, it is possible to do this for much less. For example, a simple operating microscope can be used with artificial eyes, while streaming the learner's feed over Zoom (**www.zoom.com**) using the free version of the Microrec app (**https://customsurgical.co/microrec-app/**). The learners join the video call via their phones or tablets and can then engage directly with the Orbis Volunteer Faculty mentors via audio and video. There are sometimes bandwidth or connectivity issues, depending on the location and local internet infrastructure. However, the bandwidth needed for access to platforms such as Zoom is generally sufficient.

Within Orbis programmes, remote surgical mentorship usually develops out of existing long-term relationships with clinical partners in low-or middle-income countries (see case studies) and are not currently offered to the general public. However, anyone can create an account on Orbis' digital training and telehealth platform, Cybersight.org, and immediately gain access, at no cost, to the same online courses used as part of the remote training. Access to free courses and webinars are also available to everyone with a Cybersight account. An additional feature, e-Consultation, requires users to have an active medical license in one of the low-resource countries included in this list: **https://cybersight.org/where-we-work**.

Case study 1. Remote, asynchronous wet lab training in manual small incision cataract surgery



MICS plastic eye model used for simulation training.

One of our first surgical mentoring projects, back in 2020, involved instructing ophthalmology residents in India in manual small-incision cataract surgery (MSICS).

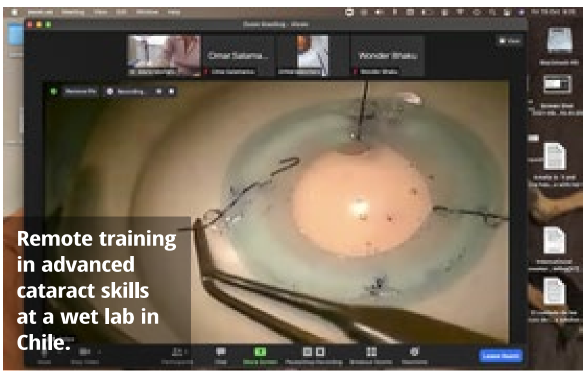
Trainees signed into the Cybersight platform and attended one live lecture a week, covering one of the specific steps in MSICS. Residents recorded two videos in the wet lab, practicing the surgical step of the week on artificial eyes – one before attending the live lecture, and one after attending it. These pre- and post-lecture surgical simulation videos were uploaded to the Cybersight platform, where they were masked, anonymised and then graded using the Ophthalmic Simulated Surgical Competency Assessment Rubric for MSICS.[1] The residents also completed an anonymous post-training satisfaction survey.

Nine residents successfully completed the training, submitting a total of 54 surgical simulation videos. The residents' average competency score increased by 5.6 points on average, which was a statistically significant improvement. Post-training satisfaction survey results indicated improved knowledge (average score of 8.7 out of 10), satisfaction with the course (8.6 out of 10), and a willingness to recommend this course to other eye health professionals (8.7 out of 10).

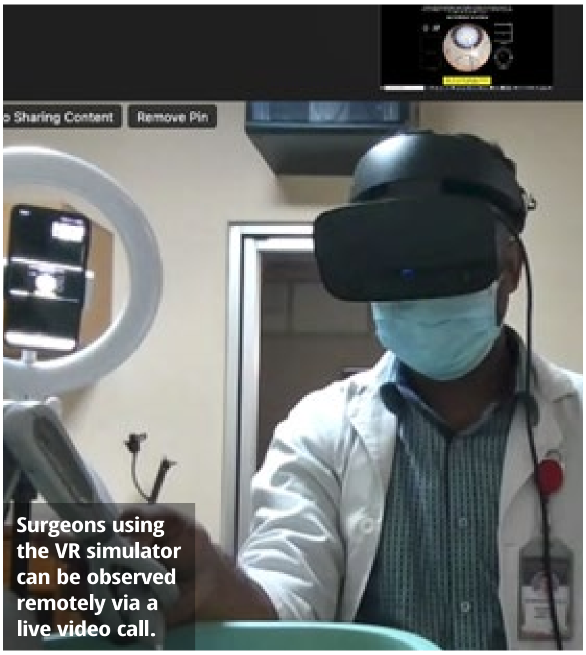
This virtual wet lab training yielded a substantial enhancement in the surgical simulation skills of participating residents. Such training models can be successfully applied in locations where access to in-person training is challenging and can also support residency curriculums.

Case study 2. Remote, synchronous wet lab training in advanced phacoemulsification skills

A more recent model of remote wet lab training focused on improving advanced phacoemulsification skills. The goal was to train six learners via synchronous (real-time) online simulation. For four months, learners joined two-day online simulation workshops, at two locations in Santiago, Chile. Learners connected their simulation microscope to an online video call and practiced their advanced phacoemulsification techniques on artificial eyes in real time, while Orbis Volunteer Faculty mentors located in either Mexico or the United States provided guidance and feedback. On day two of the monthly workshop, learners and mentors convened for follow-up lectures and discussion of the hands-on simulation training sessions of the previous day. Based on learners' experience levels, the virtual simulation training included four topics: anterior vitrectomy, iris suturing, aphakia, and small pupil. Participants' survey results showed increasing levels of comfort as the workshops progressed.



Remote training in advanced cataract skills at a wet lab in Chile.



Surgeons using the VR simulator can be observed remotely via a live video call.

Case study 3. Remote, synchronous virtual reality training

Orbis is working on a novel virtual reality (VR) MSICS simulation system in partnership with FundamentalVR (**https://fundamentalsurgery.com**) to explore the role of VR technology in remote surgical training.

The aim is to create a VR surgery experience that surgeons can share with their mentors via remote video call, in real time. The simulator will ultimately be able to score active participants on the quality of their technique, giving quantitative feedback on mistakes, while a mentor provides guidance and qualitative feedback at the end of the session.

A prototype system was implemented at six partner institutions in Bangladesh, Mongolia, India, and Ethiopia, where residents took part in VR training focused on improving MSICS skills over the course of one 40-hour week. Participant surveys indicated an increase in confidence in MSICS surgical skills at the end of the week.

Development is ongoing and Orbis is looking to launch the system in 2024. At this time, the technology is too new to estimate an exact price and to describe details around accessibility, but this will become clear as the platform continues to develop.

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More than simulation: the HelpMeSee approach to cataract surgical training

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Despite the many benefits of virtual reality surgical simulation, trainees still benefit from pre-learning and the presence of experienced instructors.

Simulation in ophthalmology is not a new concept. The use of animal eyes, vegetative material, and inanimate objects to learn and practice surgical skills has been around for many years, allowing trainees to practice surgical techniques in a safe and controlled environment.[1]

Virtual reality (VR) ophthalmic surgery simulators are able to provide a surgical training environment that is visually realistic (Figure 1) and includes built-in haptic (motorsensory) feedback systems; these create a realistic experience by mimicking the complexities of real-life surgery.

HelpMeSee, a non-profit organisation with headquarters in the USA, has developed an eye surgery simulator that is specifically designed to support the cataract surgery training courses offered at its training centres in India, France, the USA, China, and Madagscar. The courses include manual small-incision surgery, phacoemulsification, suturing, and complications management. Each course includes self study, classroom sessions, hands-on laboratory exercises (depending on the course), and instructor-led simulation-based training and feedback.

To make training available and affordable, HelpMeSee offers subsidised training in MSICS in India, China, and Madagascar.

Key principles in HelpMeSee simulation-based training

There is an old adage in training. "A simulator simulates, it does not train." A comprehensive pre-reading resource, experienced instructors, and individualised,

An instructor training a resident on the HelpMeSee surgical simulator. INDIA

Figure 1 (a) The view through the eyepieces of the simulator – seen while creating a sclerocorneal tunnel in manual small incision cataract surgery (MSICS). **(b)** The view while performing trenching in phacoemulsification.

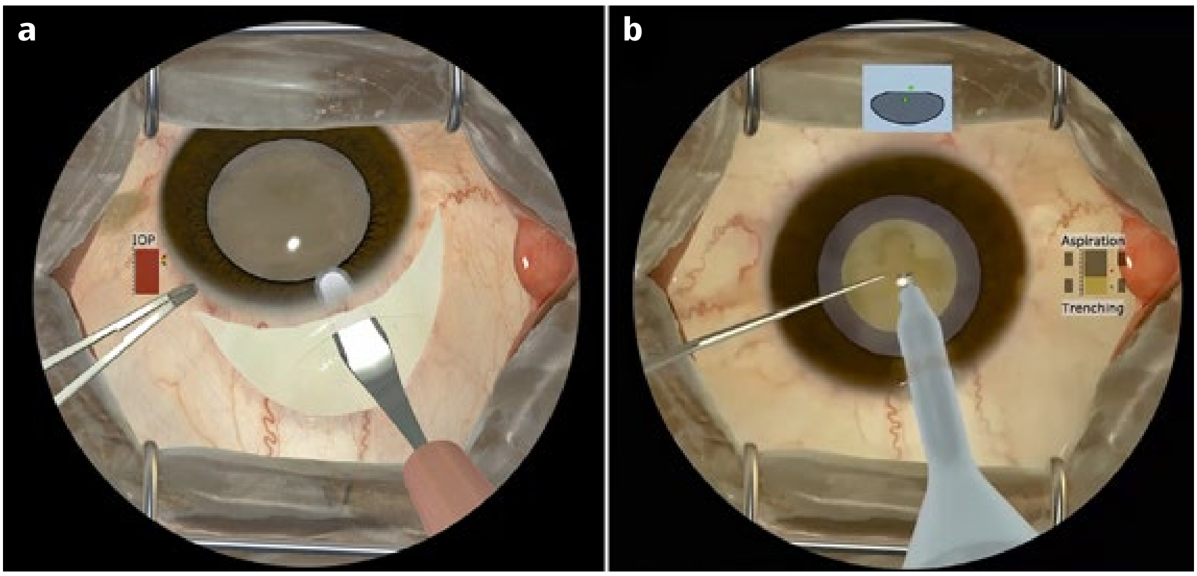
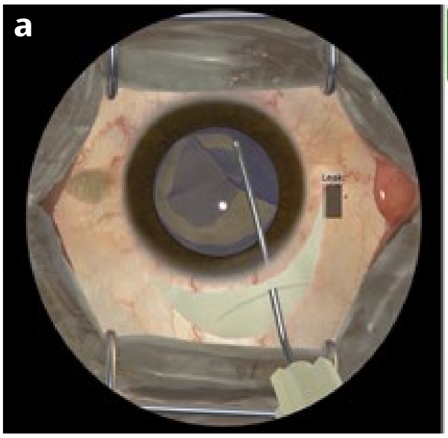


Figure 2 (a) A capsulorrhexis being created through the sclerocorneal tunnel in MSICS. **(b)** After completion of the capsulorrhexis, the system displays the performance parameters that were used to assess the attempt. An objective scoring tool evaluates each attempt and grades it as either satisfactory or unsatisfactory, based on the statistics listed under Actual Recorded' and the number of errors made.



b

Perform capsulorrhexis

Performance Parameter	Condition Matched	Actual Recorded	Outcome	Score
Maximum size of capsulorrhexis (mm)	x > 6	7.85	Maximum size of capsulorrhexis (mm)	1/1
Minimum size of capsulorrhexis (mm)	x > 4.5	6.72	Minimum size of capsulorrhexis (mm)	1/1
Contact with the iris	x = 0	0		1/1
Endothelial touch	x = 0	0		1/1
Zonular breakage (%)	x 0 - 9.99	0		1/1
Zonular breakage more than 50%	-	False	Limit not evaluated	0/0
Runout	-	False	Limit not evaluated	0/0
Task Review >			Satisfactory	5/5

objective assessment of surgeons' performance are important components of the HelpMeSee simulation-based training curriculum. Our experience has shown that each of these components play crucial roles in a trainee's learning journey.

1. Pre-reading and assessment
On enrolment, before the start of the course, every trainee is given access to an interactive e-book that is available both online and offline. The e-book begins with an overview of the anatomy of the eye, the surgical instruments needed, and the surgical steps. Next, it demonstrates each step using high quality videos and animations that are accompanied by audio commentary from expert surgeons, who also give tips on how to avoid complications. There is a test at the end of each chapter that trainees must pass before the programme starts; this ensures that everyone on the course has a solid theoretical understanding before the practical training begins.

"The constant presence of an instructor by the side of someone undergoing training on the simulator is invaluable."

2. Instructor-led training
External feedback has always been thought to be crucial to technical skill development in novice surgeons,[2] and it has been demonstrated that verbal feedback from an expert instructor leads to lasting improvements in performance. Therefore, all simulator-based training courses offered at HelpMeSee are led by an instructor who has been specially trained to provide this type of training.

The constant presence of an instructor by the side of someone undergoing training on the simulator is invaluable. The instructor can demonstrate the steps in the beginning, observe the trainee, give immediate feedback on crucial aspects such as instrument holding and surgical technique, and provide insightful comments on how to avoid complications.

The instructor is also responsible for assessing trainees' surgical competency on the simulator at the end of training.

3. Supervised practice and individualised feedback
The course includes sessions of supervised practice on the simulator, followed by feedback or debriefing sessions at the end of each day of training. Here, the instructor reviews the performance of each trainee, giving individuals positive feedback about tasks that were done well, feedback about what went wrong, and advice on how to improve.

4. Simulator-supported learning
The HelpMeSee eye surgical simulator software assesses surgical performance by comparing it with objective parameters (Figure 2) and competency assessment rubrics. This provides an objective way for instructors to understand trainees' performance and to qualify and assess their competency.

The system also supports trainees by offering immediate feedback during the prodecure (e.g., by providing a real-time alert when a trainee makes an error). Trainees can view a video recording of each task they perform on the simulator, which is an opportunity for **reflective learning**: trainees can watch the video and reflect on their performance and on how to improve.

The benefits

Several studies have been published on the validity and efficacy of virtual-reality-based cataract surgical simulators. One found that trainees who used a simulator to practice surgical techniques demonstrated significant improvements in both their surgical skills and confidence levels compared to those who did not use the simulator.[3] Other studies have consistently demonstrated that a surgical simulator is an effective training tool that can improve surgical performance and confidence levels.[4] In a randomised controlled trial, it was demonstrated that simulation based training on the HelpMeSee eye surgery simulator prior to live cataract surgery reduced the number of errors in the first twenty live operations that trainees performed.[5,6]

To find out more about HelpMeSee's training courses, reach out to **training@helpmesee.org**.

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Remote wet lab training in corneal surgery at LV Prasad Eye Institute in India

A low-cost remote wet lab model developed during the COVID-19 pandemic continues to be useful, eliminating the need for surgical fellows to travel long distances.

Tele-mentoring and remote surgical training can effectively bridge geographical distances, provide expert-led education, and foster equitable learning opportunities.[1-4] LV Prasad Eye Institute (LVPEI) is a multi-tier eye care network across southern and eastern India. It includes a centre of excellence, three tertiary centres, and 26 secondary centres. The centre of excellence delivers advanced subspeciality care to 50 million people, and tertiary centres provide this care to 5 million people. In the rural areas, the secondary centres focus on providing comprehensive ophthalmology and cataract surgical care.

Education, encompassing resident and fellowship training, is an important cornerstone of LVPEI. The Cornea Fellowship Programme initially spanned 24 months: 22 months of specialised training at a tertiary centre and two months at a secondary centre. In 2020, the programme was extended to 36 months, with nine months of comprehensive training at a tertiary centre, 12 months of training in a secondary centre, and 15 months of subspecialty training. This expansion led to a demand for ongoing corneal surgical training during the year-long secondary centre placement, to better prepare fellows for the final phase of their training.

Although distance education programmes were available in the form of classes and seminars, they fell short of providing live surgical training. To address this challenge, we developed an innovative and cost-effective model for remote wet laboratory surgical training focused on penetrating keratoplasty (PK) suturing techniques. This model aimed to equip fellows with the skills and expertise necessary to excel in corneal surgery.

Remote wet lab training model

The remote wet lab model to train fellows in penetrating keratoplasty suturing consists of three components:

- Theoretical classes/ didactic lectures
- Remote demonstration from the tertiary centre wet lab
- Setting up the wet lab at the secondary centre

Figure 1 Operating microscope with camera set up at tertiary centre.

Essential items for establishing a wet lab at secondary and tertiary centres include:

1. Artificial anterior chambers
2. Research-grade corneas
3. Suturing material (10-0 nylon)
4. Suturing instruments:
   - Hoskins forceps
   - Straight suture-tying forceps
   - Curved suture-tying forceps
   - Needle-holding forceps
   - Vannas scissors
5. External high-definition camera connected to a desktop
6. Video conferencing app (e.g., Zoom)

Additionally, at the tertiary centre, an operating microscope with a camera (refer to Figure 1) is required. At the secondary centre, a smartphone adaptor for the side scope of the operating microscope is needed.

Pre-wet lab lecture

The first step was a detailed lecture for fellows covering the important concepts of penetrating keratoplasty suturing, including the technique and challenges. We also showed surgical video clips of penetrating keratoplasty performed on patients. The Video conferencing used Zoom, and was followed by a question-and-answer session enabling fellows to raise any concerns about surgical techniques.

Remote demonstration from the tertiary centre wet lab

After the introductory lecture, penetrating keratoplasty suturing on a research-grade cornea mounted on a Baron artificial anterior chamber model number K20-2125 in the tertiary centre TC wet lab was demonstrated live by the trainer. For this set-up, we had two cameras installed – one from the microscope to provide the surgeon's view and another from the external camera on the desk. This way, fellows could observe the hand positioning and instrumentation, as well as the suturing technique, on their screens.

Wet lab set-up at the secondary centre

A similar dual-feed relay system was planned for the secondary centre. However, due to limitations in obtaining a direct video relay from the microscope at the secondary centre, we developed an innovative, cost-effective smartphone adaptor device called Focus. An external view from the laptop's HD camera was positioned at a one-meter distance from the operating table, providing a clear perspective of the hand positioning of fellows and the way they handled instruments.

Before the session, research-grade corneas, artificial anterior chamber, focus devices and instructions for assembly were sent to the secondary centres. During the session, each fellow performed a full penetrating keratoplasty suturing. All their actions were displayed on two screens for faculty to observe and provide feedback.

Regular real-time feedback on suturing techniques was given, allowing for necessary adjustments and appropriate modifications.

In this remote wet lab set-up, a trainer demonstrates penetrating keratoplasty suturing on the research-grade cornea. Figure 2 illustrates the workflow setup. The visual is transmitted through two sources : (a) shows the camera feed from the operating microscope and (b) shows the external camera from the desktop computer. Both the screens are relayed to the fellows at three secondary centres (SC1, SC2, and SC3) via Zoom, allowing each fellow to see both views on their screens.

Figure 3 illustrates the feed arrangement at the secondary centres. The feed from the trainees' side scope, connected with a smartphone (with Focus) and the display from a laptop HD camera, are relayed to the trainer monitor at the tertiary centre. Each trainee's two screens, showing the surgeon's view and the external view, are relayed to the trainer. This setup enables trainers to provide real-time feedback to fellows, so they can improve their suturing techniques and make the necessary adjustments.

Key learnings and way forward

Telementoring and virtual wet lab sessions emerged as vital tools for continuous medical education during the pandemic. While reliance on virtual platforms has decreased post-pandemic, they remain essential in our educational model, ensuring fellows' ongoing engagement in corneal procedures during their second year of study and enhancing their training beyond cataract surgeries.[5,6] Besides penetrating keratoplasty, there are training modules for ocular surface procedures, corneal tear repair, perforation management, and donor tissue preparation for endothelial keratoplasty. The cost-efficient nature of our approach, with

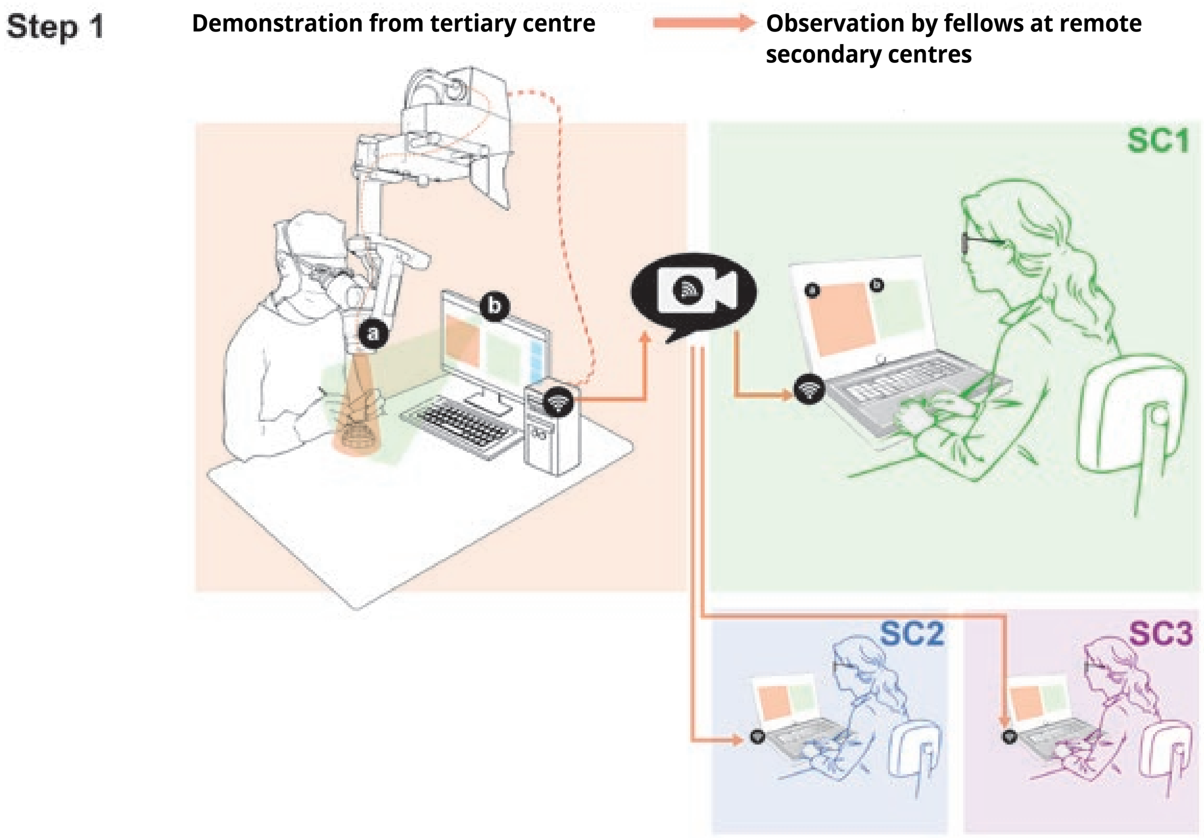


Figure 2
Remote wet lab setup at the tertiary centre.

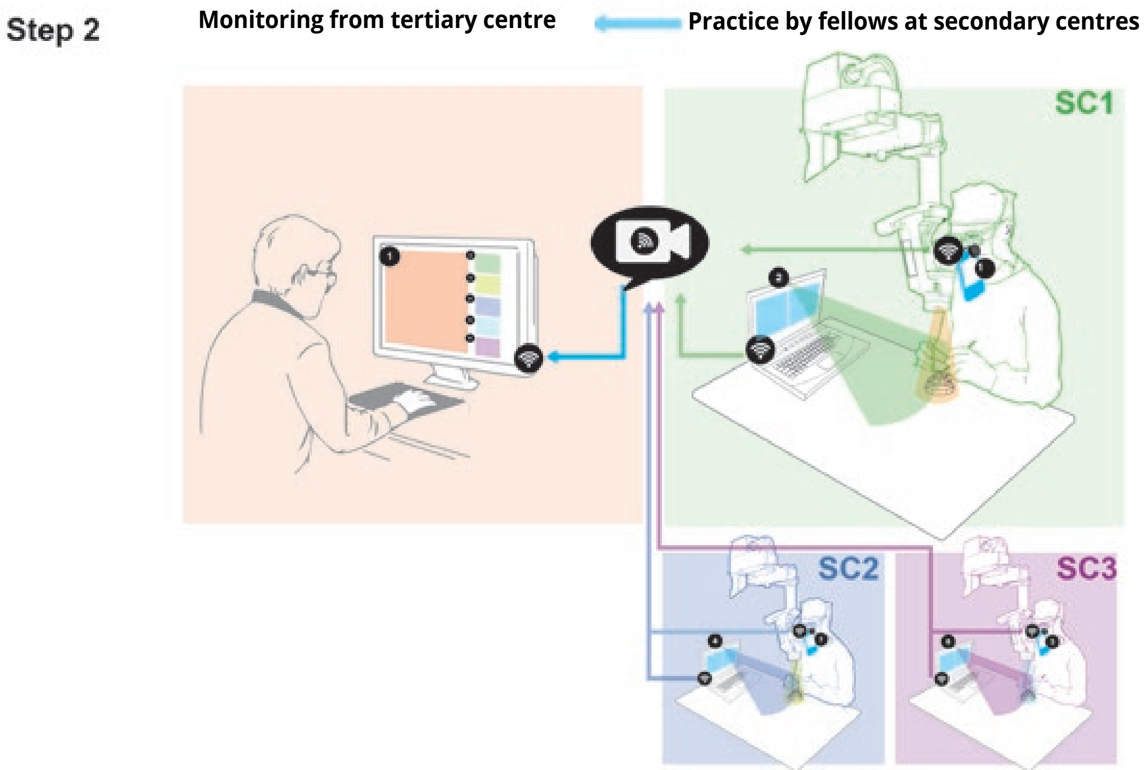


Figure 3 Remote wet lab setup at the secondary centres.

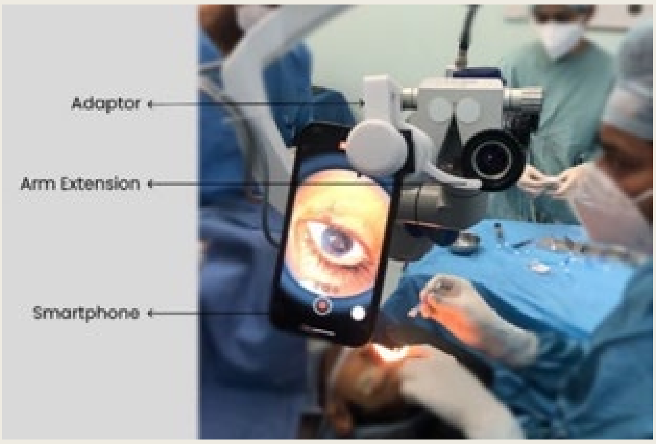
a manufacturing expense of approximately US $3 for the Focus device, permits easy replication for remote education, saving time and costs by eliminating the need for fellows to travel from remote secondary centres.

There remain occasional connectivity issues due to low rural internet speeds. In some secondary centres, dual video relay is not possible because of the lack of side scopes in operating microscopes.

It would be useful to include faculty-graded objective assessment alongside fellows' subjective feedback. While replicating an in-person instructor's intuitive feedback is a challenge, the model's effectiveness remains evident.

In conclusion, this low-cost remote wet lab model has proved to be feasible and effective for corneal surgical training. Regular and more frequent sessions hold promise for a more significant future impact.

About the Focus device



The Focus device was developed in-house at the Centre for Technology and Innovation, LV Prasad Eye Institute at a cost of about Rs 250 (roughly US $3). The device can be attached to the assistant scope, providing the surgeon's view.

The device has two main parts: the adaptor and the screw. It was created using Solidworks 3D design software and prepared for 3D printing using Cura software. The design was translated into G-code machine language, saved on an SD card, and put into the Ultimaker 2+ 3D printer.

The device is made from a type of plastic called PLA (polylactic acid). After it is 3D printed, extra portions, or supports, are removed using pliers and cutters. To ensure the smartphone does not slip from the microscope eye piece, a 4 mm thick, soft foam padding is added. An arm extension is also provided as additional support.

Once the focus device is attached to the side scope of the operating microscope, doctors can use their smartphones to live-stream operations in real-time.

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Wet lab and live surgical training at Aravind Eye Hospitals

Wet lab and live surgical training are both vital components of the residency programme in ophthalmology at Aravind Eye Hospitals in India.

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Before wet lab training begins, trainees attend lectures on the surgical anatomy of the eye, as well as intraoperative complications and their management. They watch detailed videos of each surgical step to get an in-depth understanding of the competencies required, the overall process, and the attitudes needed for managing outcomes.

The wet lab allows surgical trainees to become familiar with the handling of surgical instruments, develop hand–eye coordination, and practise surgical steps. Good wet lab training can improve the outcomes of operations performed by trainees.[1]

By using phaco machine in the wet lab, surgeons learn the principles of phaco while practising use of the foot pedal. INDIA

Setting up the wet lab

An ideal wet lab simulates an ophthalmic operating room, where trainee surgeons can experience what it feels like operate on an eye. To keep costs down, refurbished equipment and instruments can be used. A basic ophthalmic surgical wet lab includes the following:

- Operating microscope (fitted with a camera and screen for external viewing)
- Ophthalmic surgical instruments (refurbished, or re-sterilised 'single use' instruments)
- Animal or human cadaver eyes, and devices to mount them
- Phaco machine (refurbished).

Training is overseen by a designated trainer, and surgeons practice while being assisted by an experienced operating theatre nurse.

Practising on goat eyes

A goat eye is preferred in the wet lab as its anatomy and tissue texture closely resembles that of the human eye. When using goat eyes, ensure that the globe is not perforated and the cornea does not become dry.

The goat eyeball is mounted onto a metal stand using a roll of gauze, wrapped around the equator so the eyeball snuggly fits on the stand (Figure 1). Next, we inject intravitreal formalin to form a firm globe.

Before wet lab training begins, trainees attend lectures on the surgical anatomy of the eye, as well as intraoperative complications and their management. They watch detailed videos of each surgical step to get an in-depth understanding of the competencies required, the overall process, and the attitudes needed for managing outcomes.

The wet lab allows surgical trainees to become familiar with the handling of surgical instruments, develop hand–eye coordination, and practise surgical steps. Good wet lab training can improve the outcomes of operations performed by trainees.[1]

Figure 1 A goat's eye held in place using gauze.

Trainees can practise creating sclerocorneal tunnels on four sides of the globe, and can practise capsulorrhexis and hydrodissection. However, a goat eyeball offers limited scope for practising nucleus prolapse and delivery.

To prepare a goat eye for phacoemulsification practise, cover the cornea in wet gauze to prevent drying and then place the eye in a combination microwave oven, set to 100°C, for four seconds. This renders the nucleus hard and leathery, and allows trainees to practise trenching, dividing, chopping, and emulsification of the nucleus.

In settings without access to a microwave oven, we create a sclerocorneal tunnel, implant a nucleus that was extracted during manual small-incision cataract surgery, and suture the tunnel closed. Phacoemulsification can then be practised on this nucleus.

Goat eyeballs can also be used to practise trabeculectomy and implantation of glaucoma drainage devices, in addition to cataract surgery.

It may be possible to use human cadaveric eyes (that are unfit for transplantation), to practise keratoplasty. It is part of the scrub nurse's role to prepares the cadaveric eyes and ensure proper disposal of the eyeballs afterwards.

Other ways to practise

The polyurethane foam sheets in which ophthalmic sutures are packaged can be used to practise suturing and making sclerocorneal tunnels.

The thin polythene film that is sometimes used in the packaging of intraocular lenses can of the used to practise capsulorrhexis. A circle of 6 to 7 mm is marked over the polythene sheet with a pen, and trainees can use a cystotome to practise rhexis within the mark. This allows for multiple attempts, which cannot be done on a cadaver eye.

Once a trainee has made 20 sclerocorneal tunnels on goat cadaveric eyes, completed 100 attempts at capsulorrrhexis on polythene film, and 20 sets of sutures in polyurethane foam sheets, they are permitted to move on to live surgical training.

Live surgical training

Each group of trainee surgeons is assigned to an experienced surgeon, who will be responsible for training them. During the first four to five days, trainees are expected to closely observe while the senior surgeons operate on patients. They are also expected to learn how to handle different instruments, maintain aseptic precautions, and establish the correct physical posture during surgery.

Following the observation period, live hands-on training begins on selected patients: those with uncomplicated immature cataracts and who have a well-dilated pupil, normal anterior chamber depth, and no ocular comorbidity. Surgical training rooms are equipped with observation facilities for trainees and the trainer: either microscopes with an observer-scope and/or a camera and a monitor for viewing.

The training is administered in a step wise fashion: trainees can progress to the next step after performing the previous step satisfactorily. For instance, a trainee will be allowed to perform capsulorrhexis only after performing sclerocorneal tunnels satisfactorily.

Patient safety is a priority. So, if a trainee faces difficulty in any step, the surgery is immediately taken over by the trainer.

Feedback and review

The trainer and trainees review the recorded surgery videos and detailed feedback is given on the same day as the surgery. Objective scoring of the surgery is done using the ICO-Ophthalmology Surgical Competency Assessment Rubric (ICO-OSCAR) in the trainee's log book.[2] Intraoperative complications and any difficulties faced during a surgical manoeuvre are also noted in the log book.

Monitoring post-operative outcomes

The effectiveness of any surgical training programme is judged by the post-operative outcomes of trainee surgeons. It is mandatory for all trainees to do post-operative assessment of the operations earlier in the day, together with their trainer. The log books are also evaluated by a senior consultant, who provides further insights into the surgical skills that a trainee should acquire.

Aravind Eye Hospitals' CATQA (Cataract Quality Assurance) system tracks long term surgical outcomes.[3] Quarterly complication review meetings are held where surgeons with high complication rates are identified and given focused re-training going back to wet lab and live training to fine tune specific aspects of their surgery. Although it applies to any surgeon, most re-training happens in newly certified surgeons. It has been estimated that surgeons need to perform manual small-incision cataract surgery an average of 300 times before their complications levels stabilise at acceptable levels.[4]

Figure 2 Polyurethane foam sheets can be used to practise suturing.

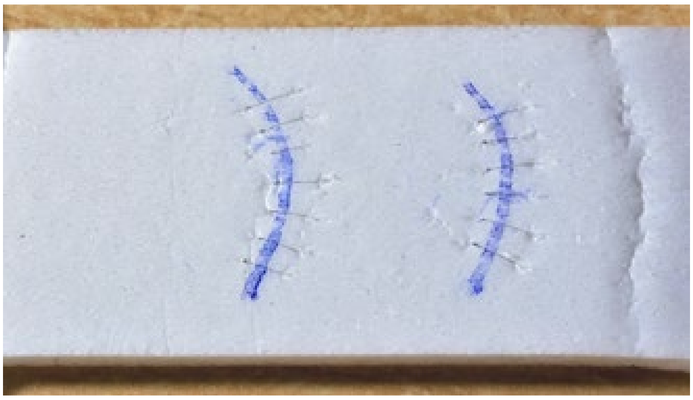

Figure 3 Capsulorrhexis can be practised on a polythene sheet.

Trainees who perform exceptionally well are provided with higher order surgical skill training, such as tackling complex cataracts and managing intraoperative complications.

It is vital for a training centre to establish structured surgical training and set up tools to assess the effectiveness of training strategies. The learning curve may not be uniform among trainees; hence it is imperative to periodically monitor the surgical performance data of amateur surgeons so that focused re-training can be accomplished. Surgeons who perform well can be promoted to undertake high-volume surgery and manage complex surgical scenarios.

Table 1 Tips for learners and educators

Tips for learners	Tips for trainers
Have a thorough understanding of surgical anatomy before starting surgical training.	Assess the surgical knowledge of a trainee before initiating training so that you know what level of training is needed.
Assess each surgical step as it is being performed. This will help you to identify and prevent complications.	Do not take for granted any aspect of the procedure. Ensure that you teach every detail of each surgical step.
Pay close attention to each surgical step because it has a direct bearing on the outcome of the next step.	Teach good surgical habits right from the start of the training period.
Complications are an inherent part of surgical training. Be open about your concerns and discuss them with senior colleagues who can help you to improve your skills.	Immediately correct any minor deviation from the preferred technique.

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Inspecting and unbending surgical needle holders

A needle holder, also called a needle driver (Figure 1), is made from stainless steel and is used to hold a suturing needle during surgical procedures.

To maintain a firm grip on the needle, the jaws have textured patterns either etched directly on the stainless steel or on a replaceable tungsten carbide insert, which grips the suture needle more precisely and wears out much slower than stainless steel. Needle holders with tungsten carbide inserts normally have gold-plated rings.

A needle holder must be matched to the needle size for which it is intended.

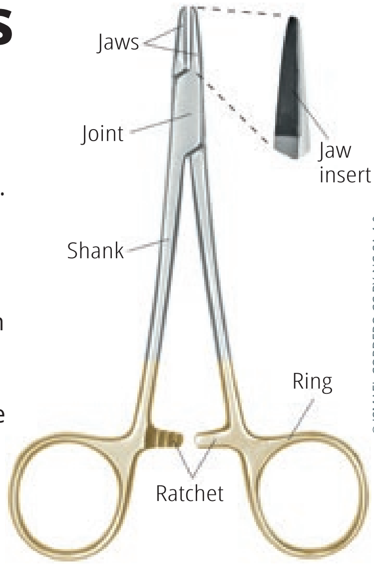

Figure 1 The main parts of a needle holder. The handles consist of a shank, a ring, and a ratchet mechanism that locks the needle in place.

Postoperative care

Open the needle holder by separating the ratchet. Prevent blood from drying onto the instrument by soaking it in an enzymatic solution. Alternatively, place a moist towel, saturated with water, over it within 20 minutes of use.

Inspection and testing

A needle holder should be able to hold a hair on the back of your hand. If not, it is not functioning properly. With use, the jaw surfaces will wear out and stop making full contact, which affects their grip. Bends and cracks can also develop on the jaws and other parts of the needle holder.

It is important to inspect needle holders after each procedure and before sterilising them. Use a bright lamp and a magnifying glass or microscope to check for any of the following flaws.

- **Bent or worn jaws.** When the needle holder is held up to a bright light in the closed position, no light should shine through between the jaw surfaces. If the light only shines through a small portion of the jaws, either the jaw or the jaw insert is worn out. A worn jaw insert must be replaced by the manufacturer or a qualified vendor. If the jaw surface is worn (Figure 2), the entire needle holder must be replaced. If the light shines through a significant portion of the surface (Figure 3), one of the jaws is probably bent. Follow the procedure described later in this article to correct it.
- **Cracks in the jaws or joint.** Even small cracks compromise the integrity of the instrument. This means it should be sent to the vendor or manufacturer for repair.
- **Cracks in the jaw inserts.** The majority of insert damage occurs at the tips. The insert must be replaced if cracks are seen. If the tip of an insert looks and feels significantly less coarse than the rest of the insert, it should be replaced.
- **Rust and stains.** In order to determine whether a brown or orange discoloration is rust or a stain, rub a pencil eraser aggressively over part of the discoloration. If the discoloration cannot be removed and if there are pit marks, then it is rust and requires soaking in a rust removal solution and/or brushing carefully with a brass brush. If it can be removed and the metal underneath is smooth, then it is a stain and it can be removed by soaking in a stain removal solution.
- **Loose joint.** Open the instrument, grab one ring handle in each hand and gently push one handle up and down. There should be some give-and-take in the instrument, but if it feels too loose it should be repaired.
- **Poor ratchet fit.** Check that the jaw tips close in the first ratchet position and that the entire jaw closes in the third ratchet position. If a needle held in the jaws of a needle holder can be easily turned by hand with the instrument locked in the second ratchet position, repair is needed.

Preparing for sterilisation

If any dried blood or discoloration is discovered on the needle holder, the instrument must be cleaned before being sterilised. Needle holders should always be sterilised with the ratchets disengaged.

Correcting bent instruments

Bent needle holders can sometimes be corrected using a pair of flat-tipped pliers using the steps below. (**Note:** these procedures should not be used for needle holders with tungsten carbide inserts since they are brittle and can fracture easily.)

1. Close the needle holder, and look at it from the side. If you notice that the jaw tips are not aligned (Figure 4), then at least one tip is bent and you can try to straighten it with flat-tipped pliers (Figure 5). If it is not obvious which tip is bent, you can take turns bending both tips so that they align. **Note:** do not use too much force; bend the tips little by little.
2. Close the needle holders completely and hold them against a light. If light shines through the jaw surfaces (Figure 3) then you will need to bend one or both of the jaws towards each other.
3. If the ratchets do not hold anymore, bend the handles towards each other.
4. After unbending, test the needle holder by grabbing a hair on the back of your hand – the hair should not slip out.


Figure 2

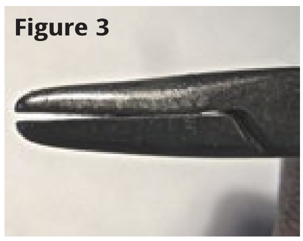
Figure 3


Figure 4


Figure 5

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Sharpening and tightening surgical scissors

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Surgical scissors consist of a pair of metal blades, pivoted so that the sharpened edges of each blade slide against each other when the handles opposite to the joint or pivot are closed.

The cutting edge of each blade is where the inner surface and the cutting surface meet (Figure 1). The two cutting edges cut as they slide over each other. The angle of the cutting surface is usually between 0 and 15 degrees from the horizontal. Scissors with a very steep angle (nearer 15 degrees) are extremely sharp and are meant for cutting soft tissues such as conjunctiva. Scissors with a less steep angle are meant for cutting harder tissues.

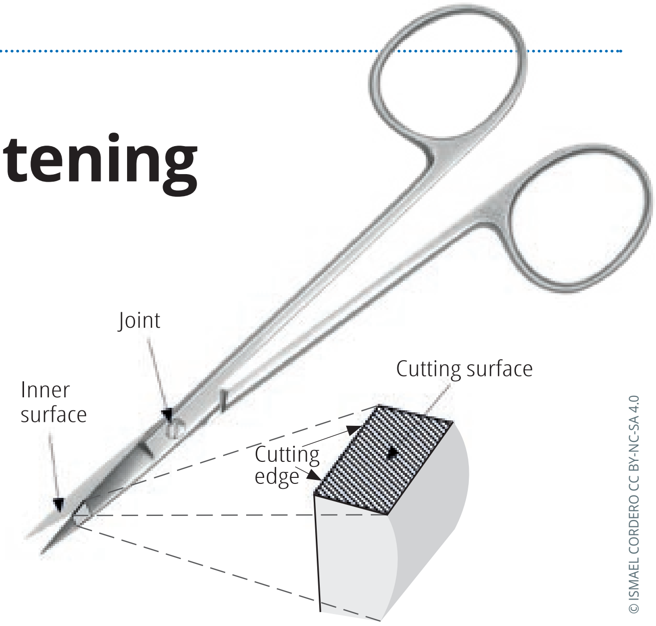


Figure 1 The cutting edge of each blade is where the inner surface and the cutting surface meet.

With repeated use, the sharp cutting edges become rounded and pits or gaps can appear, making the scissors blunt. These pits will be visible as changes in the reflection when you examine the cutting surfaces in bright light.

The sharper the cutting edge, the quicker the scissors will become blunt. You should never use scissors to cut material that the scissors are not suitable for, or they will become blunt very quickly. If blunt scissors are used, the tissue will be clasped instead of cut, resulting in contusion of the tissue and ineffectual wound healing.

Testing the scissors

1 Stretch a piece of cotton wool so that a small, straight piece is formed, with the width equal to the length of the scissor blades.
2 Cut this piece using the whole length of the scissors.
3 Gently pull the cotton wool out while the scissors are still in the closed position. If the scissors are working well, there should be a nice, straight cut in the cotton wool. If not, and the scissors clasp the cotton wool, this may be because the scissor blades are blunt or because the joint is too loose.

Sharpening the scissors

A pair of scissors is sharpened by filing off a very thin layer of the cutting surface to create a new cutting edge.

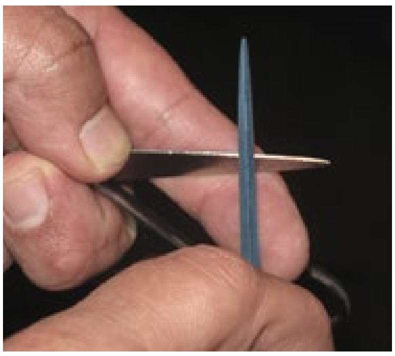
You may use a small, fine triangular file; however, if you have access to a triangular sharpening stone (800-1,200 grit) you will achieve even better results.

To obtain the smoothest surface possible, place a few drops of sewing machine oil on the sharpening stone.

Note: Always sharpen scissors by filing along the cutting surface, never on the inner surface.

1 Hold the scissors firmly in one hand (your left hand if you are right-handed, and vice versa), with the back of one blade resting on the end of your index finger and the cutting surface visible (Figure 2). Keep the joint open by pressing your thumb against the hand-piece of the scissors.
2 Place a bright desk lamp at the same height as your eyes. Let the light reflect on the cutting surface. Rotate the scissors slowly in both directions. When the reflection is at its brightest, the surface is horizontal. If you keep the sharpening stone horizontal as well, you will preserve the original angle.
3 Always start sharpening at the tip of the instrument, to prevent rounding off the tip. Make a gentle stroke in a forwards direction (away from you) and simultaneously towards the joint. Make sure to cover the whole surface with each stroke so that you do not create different levels along the length of the blade. Do not apply too much force. The repetition of the movement is what sharpens the scissors.
4 Repeat until most of the pit reflections are gone. If the pits are too deep, the amount that has to be filed off to get rid of them may be too large and you run the risk that the cutting surfaces of the scissor blades no longer touch each other. It may be necessary to remove such scissors from circulation.
5 After sharpening, a burr (an accumulation of filed metal) may be formed on the inner surface. This burr has to be removed. If not, it will damage the cutting edge on the opposite side during cutting. You can remove any burs by scratching them off with your fingernail.
6 Repeat the procedure for the other scissor blade. Always sharpen both blades.
7 Clean the scissors thoroughly after sharpening. Any remnants of oil and metal on the instrument can cause inflammation in the eye.

Figure 2 Sharpening scissors.



Tightening a loose joint

Another reason why scissors may not cut properly is a loose joint. If the screw or rivet is not tight, the distance between the two inner surfaces will be too large, causing the cutting surfaces to not touch each other. As a result, tissues will be clasped instead of cut.

1 Place the scissors on a flat, hard surface.
2 Close the scissors so that the blades are top of each other.
3 If the joint has a screw, then tighten it. If it has a rivet, then proceed to the next step.
4 Place the tip of a pin punch on top of the rivet head, keeping the pin punch perpendicular to the scissors.
5 While holding the scissors down, have someone else hit the top of the pin punch with a small hammer.
6 Test the scissors after every hit, to prevent them from becoming too tight.

Adapted from Haddad D and Worst JGF. Standard Operating Procedure Manual for the Maintenance and Repair of Microsurgical Instruments. 1992.

Article updated February 25th 2013.