

# A CURRICULUM FOR OCULAR TRAUMA

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# I. INTRODUCTION

You will spend the next four four-hour sessions in a didactic/lab course that will give you the fundamental surgical skills necessary to repair corneal trauma with proficiency. We have developed a course that gives residents a very steep learning curve; so do not worry if things seem a bit awkward at the beginning. They won't stay that way long.

Our curriculum uses penetrating keratoplasty as our surgical model. One cannot accurately and reproducibly place sutures around the perimeter of a corneal graft until one has superb manual dexterity. That dexterity is a prerequisite for the more difficult chore of closing the more complex traumatic corneal wounds you will repair during your chief residency.

We want you to experience success early in the practice lab experience. That will require you to do prepare academically. We have developed a method of suture placement that guarantees rapid success if you follow the steps precisely. Take the time to study chapter 2 in detail.

**You have two tasks to complete before you arrive for the first wet lab session.** First, read the sections on stability and fine motor control and practice these motor movements at home until they are a part of your muscle memory. Second, you should know the steps in the suture process so thoroughly that you can easily recite them in order.

## II. STEPS TOWARDS SUCCESS

### 1. PRE-WET LAB FUNDAMENTALS

#### A. Suture technique and tying technique

- 1.Pre-wet lab reading in steps to place sutures consistently.
- 2.Pre-wet lab reading in steps to approximate wound and tie knots consistently

#### B.Stability

1. Discussion of hand positions that maximize stability

#### C. Fine motor control

- 1.Discussion of basics of fine motor control
- 2.Exercises to improve fine motor control
- 3.Specific instrument position for the needle holder

### 2. THE PENETRATING KERATOPLASTY PRACTICE LABS

#### A.Lab 1

Applying text lessons in surgical craft to the penetrating keratoplasty model. This 3-4 hour lab session with instructor will teach you the basics suturing; and of hand positioning for both the needle holder and the Colibri forceps. Our main focus is on good fundamentals and consistency. We will actually pass few sutures today. We are more interested in showing how you must stabilize your hands and manage the instruments.

#### B.Lab 2

Fine-tune the lessons of lab 1 under staff supervision. Begin to feel comfortable placing sutures in more awkward positions around the graft perimeter.

#### Lab 3

Final refining of technique prior to grading exercise in lab 4. Gain proficiency in 3:00 and 9:00 suture positions

Lab 4

Non-supervised wound closure followed **by grading suture quality**.  
Debriefing on metrics follows.

# PRE-WET LAB FUNDAMENTALS

## STABILITY

### What causes tremor?

What causes a hand to shake during surgery? Not the hand! There are almost no muscles in the hand itself. The culprits in tremor are found in all of the muscle groups above the wrist from the forearm all the way up to the shoulder girdle. Tremor is no longer an issue when you neutralize the effect of those muscle groups.

### How to neutralize tremor from the wrist up?

- Keep the elbows close to the trunk. That keeps the deltoids and other shoulder muscles quiet.
- Keep the wrist in a neutral position relative to the hand. Flexion towards the ventral hand and towards the thumb are particularly tremor-inducing.

### Positions that stabilize the hands

You can never accomplish consistent suture placement until you establish a stable hand base. Think about the tolerances necessary to accomplish your mission of consistently deep, straight, uniformly long sutures. To consistently place a suture between 75% and 100% depth in a cornea 800 u thick requires you to place the suture between 600 and 800 u. To keep the suture length on each side of the wound within 10% of 1 mm gives you a tolerance of 0.9 to 1.1 mm. There is no wiggle room here. **YOU NEED A STABLE BASE FOR YOUR FINE MOTOR CONTROL MOVEMENTS.**

Two types of hand positions can lead to a stable base.

**Pronated hand with perpendicular stacking of pinkie through middle finger.** Note the fingers that allow fine motor control, thumb to middle finger, are always in contact with the underlying stabilizing fingers in a good stack. This position is most stable when the base fingers are flexed and the edge of the hand is flush to the patient's head.

**Total hand pronation with middle through pinkie finger perpendicular to face.** Palm flush to the head, base fingers close to perpendicular to the patient's head, and the fine motor fingers in contact with the base fingers.

## **EXERCISES FOR FINE MOTOR CONTROL AND 3 POINT FIXATION**

A surgeon uses the index finger, the middle finger, and the thumb for fine motor control of instruments. A surgeon has best control of range and flexion of these instruments if they are held with the tips of the fingers with the joints in a convex position.

This position is unnatural for a novice surgeon because we rarely hold instruments in this position in day-to-day life where a “pencil hold” position is more usual. Your lab experience will be easier if you practice maneuvering your instruments before entering the practice lab. The exercises are simple.

### **Exercise for forceps.**

Secure a jewelers forceps with your dominant hand using the tips of the index finger, middle finger, and thumb. To stabilize the rest of the hand, use one of the two stability positions described in the last section. .

With the forceps tips closed, practice rotating the forceps

- Up and down
- Right and left
- Through a roll rotation along the axis of the instrument.

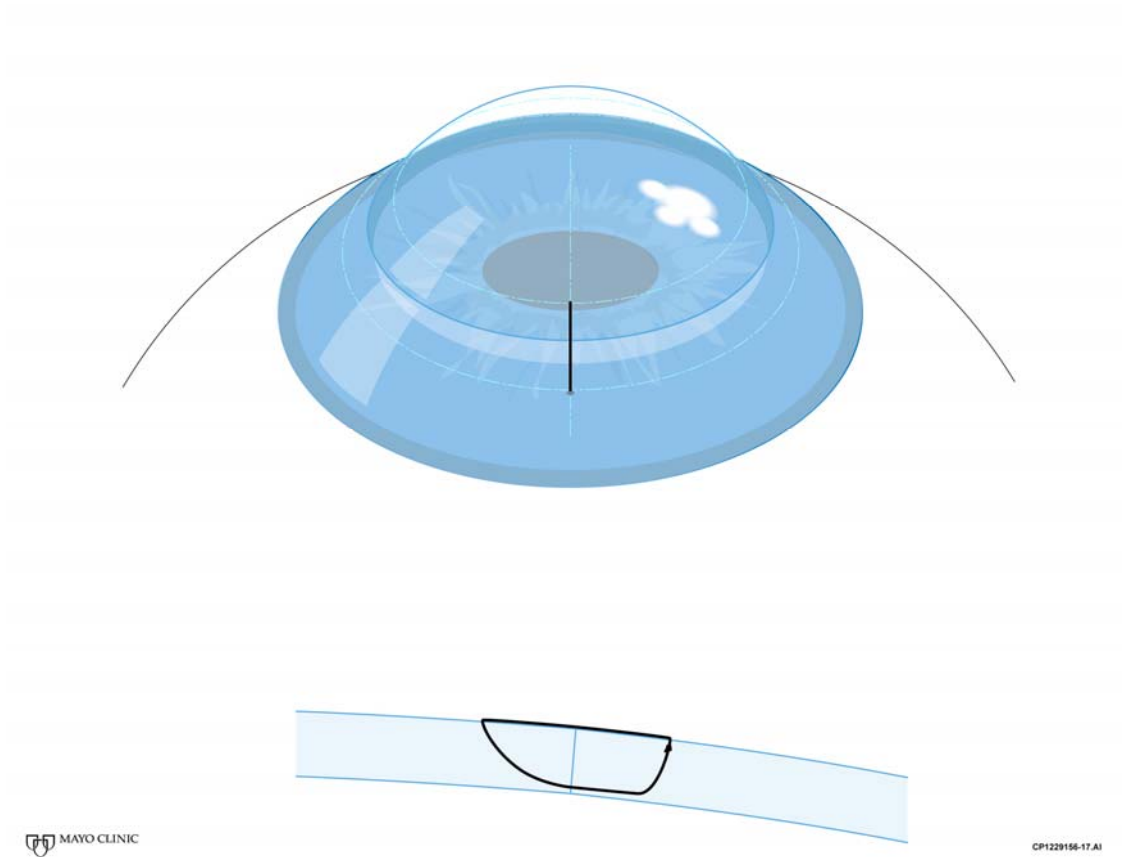
You should try to use the most minimal touch on the fingertips to maximize the excursion of the instrument.

Now practice opening and closing the tips of the forceps. You want to perform 3 tasks equally well:

- Bringing the forceps tip controlled by the index finger towards a non-moving forceps tip controlled by the thumb (most natural move)
- Move the forceps tip controlled by the thumb towards a non-moving forceps tip controlled by the index finger
- Move the two tips at equal speed until they contact each other midway between their original positions

### III. TEXT INSTRUCTION IN SUTURE TECHNIQUE AND TYING TECHNIQUE

Below is a figure that shows everything we want to see in every suture you place around the circumference of a corneal graft



Characteristics of this suture:

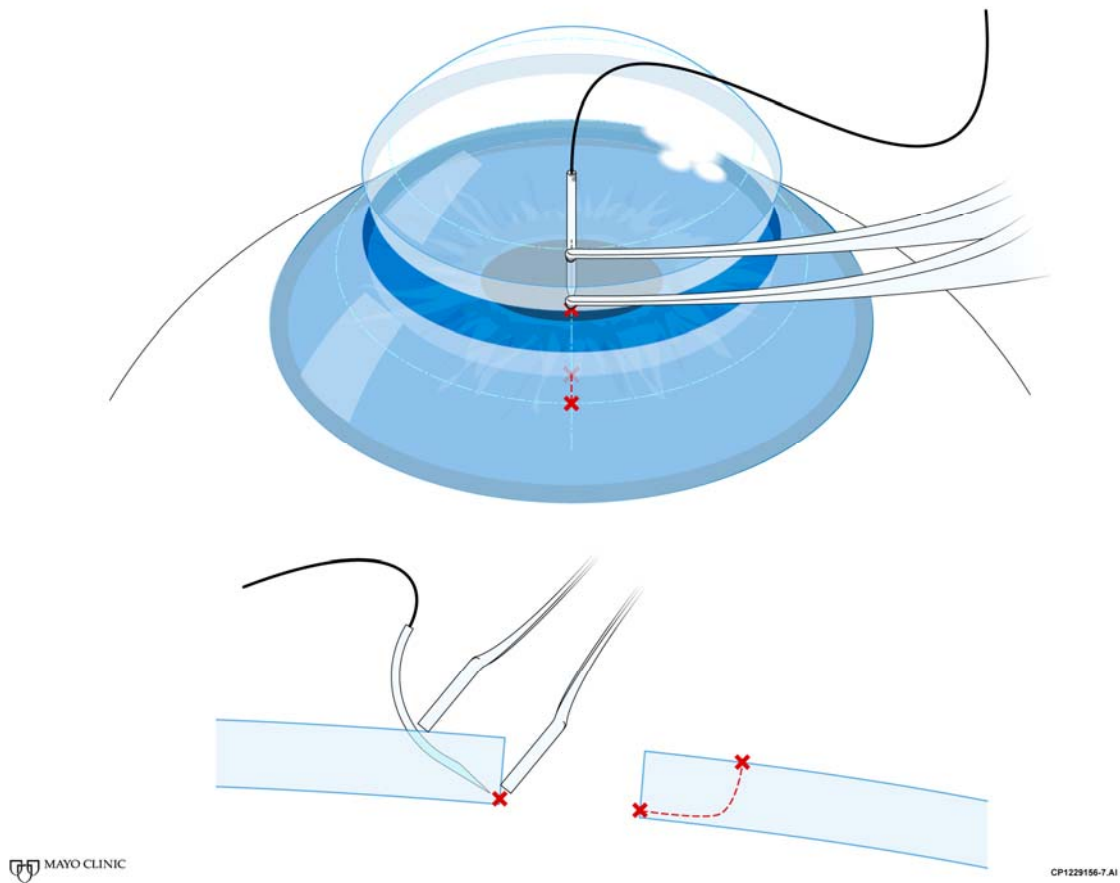
Graft and host entry positions equal and at a predetermined distance from the graft/host interface

Straight suture perpendicular to the graft/host interface

Suture passing through the stroma on both graft and host at equally deep stromal positions.

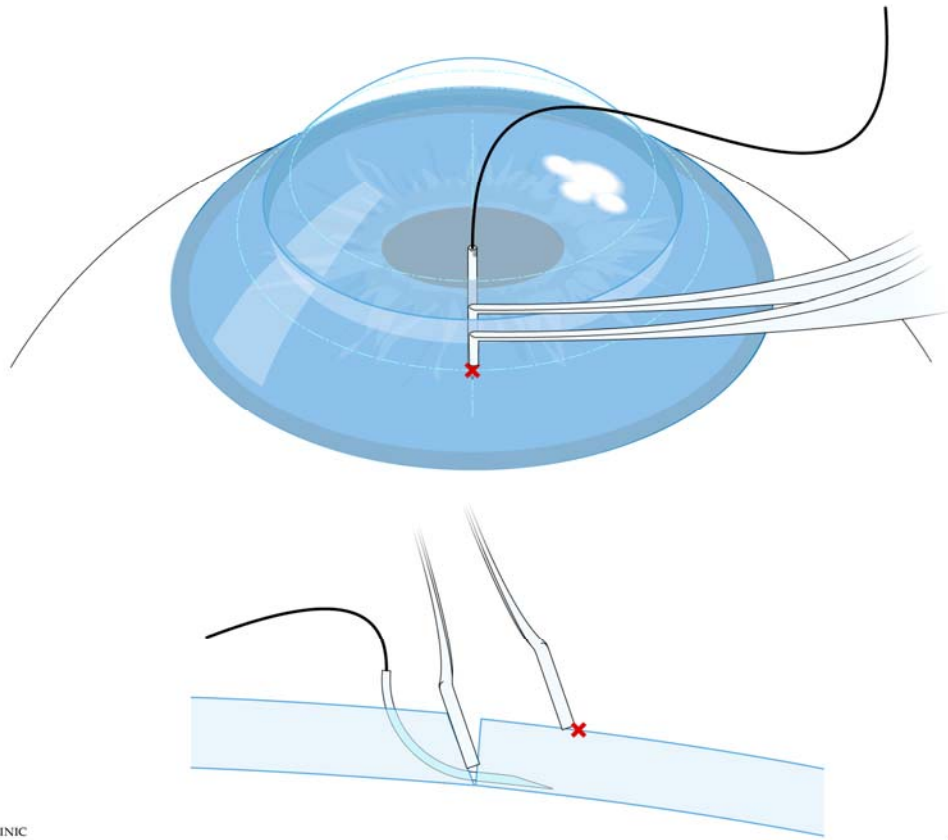
Wound shows good apposition without undue compression of the wound

There are 3 basic steps that will make high quality suturing occur with consistency. They are shown below.

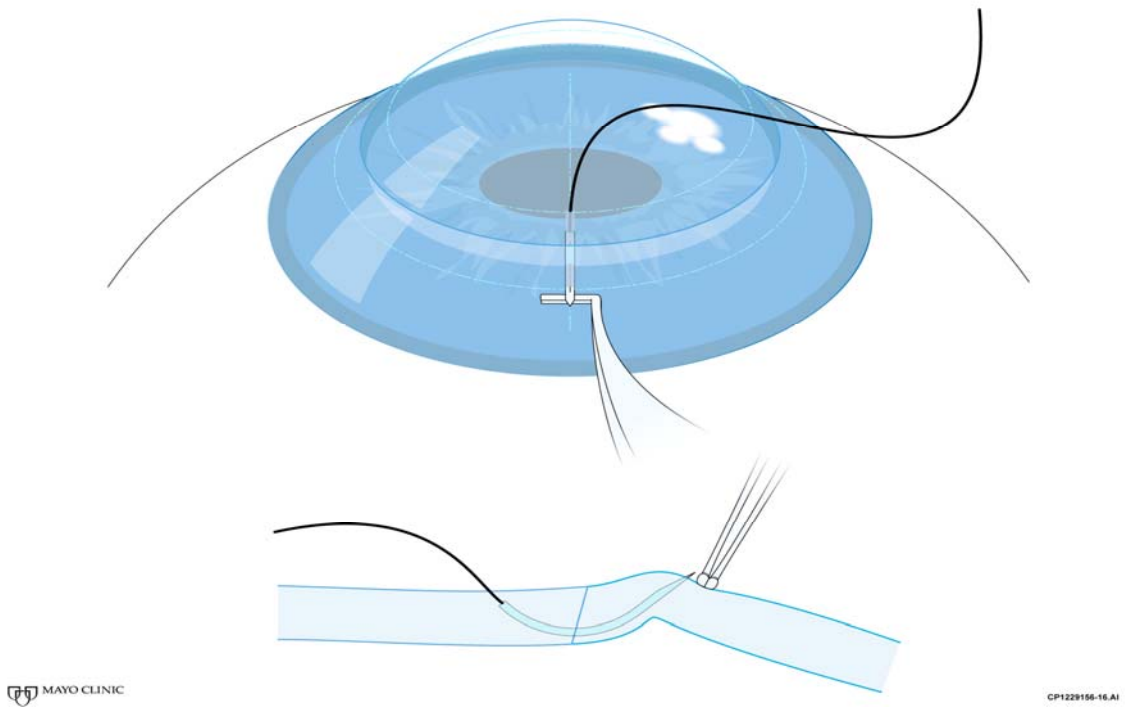


Step 1 Having placed your forceps and needle in proper position, drive the needle through the cornea along the straight line as shown.





Step 2 Having placed your forceps and needle in proper position, drive the needle parallel to the posterior surface of the cornea for the correct distance

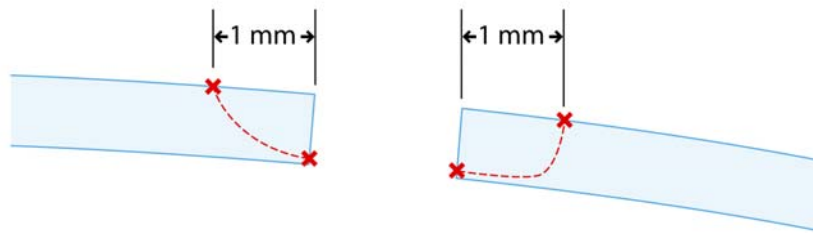
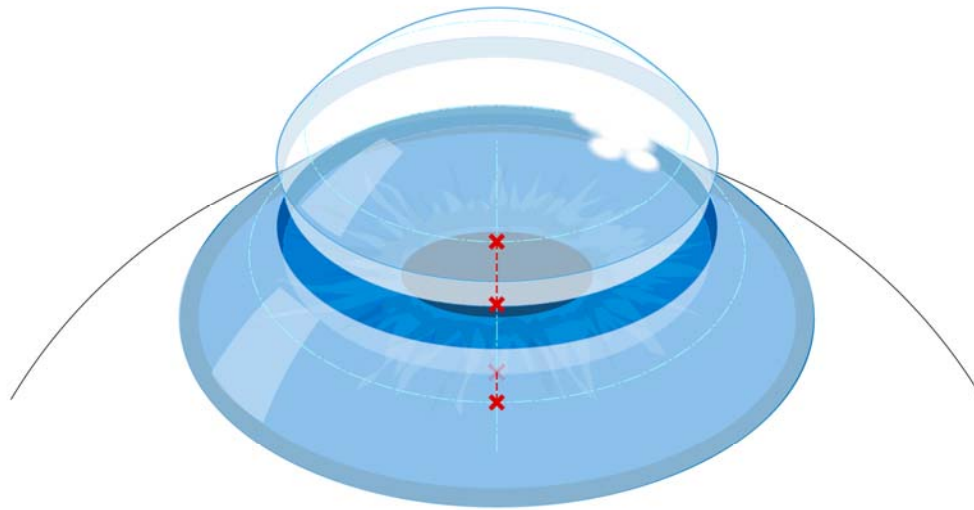


Step 3 Rotate the needle point so that it points to the surface and then use gentle downward pressure with the Colibri to drive it to the surface.

Those steps seem easy enough. Each step is easy if you have your needle and forceps in perfect position. The next section breaks down the maneuvers that have to precede each of the three main steps to make the 3 main steps easy.

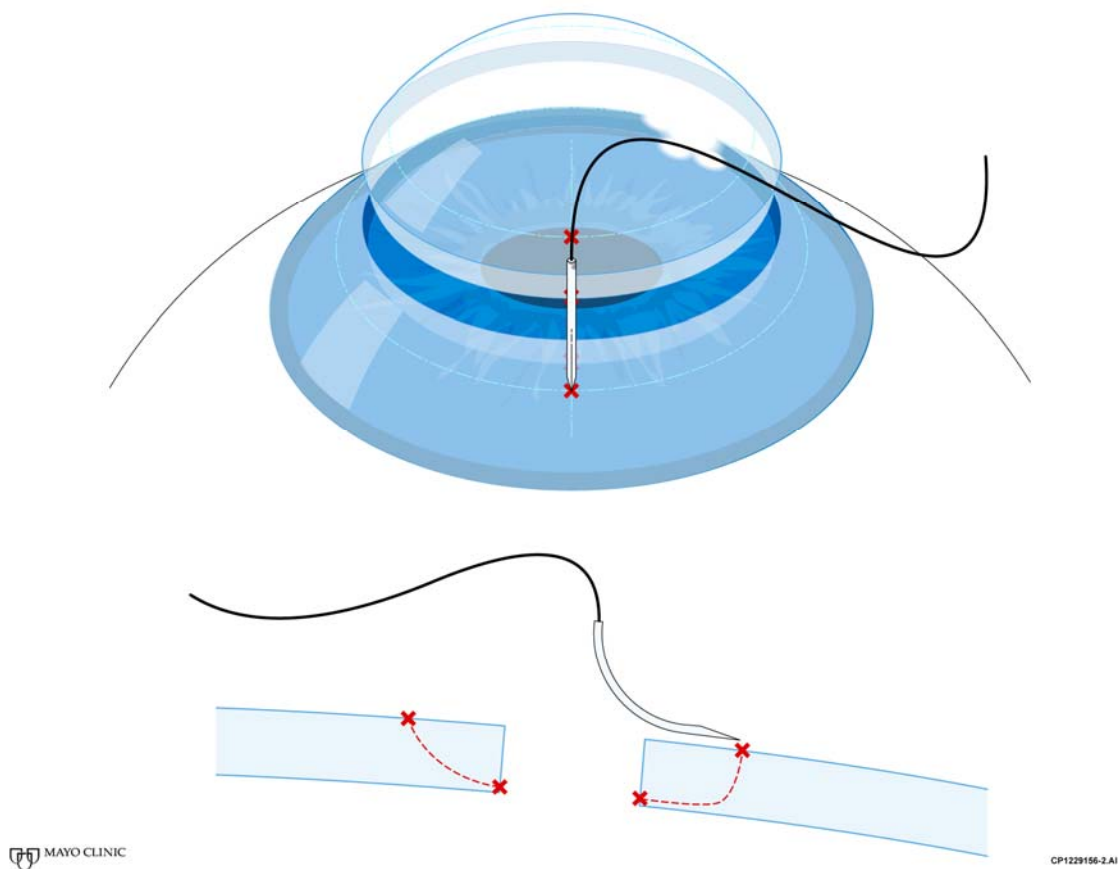
Each of the following pages contains one figure that represents one step in good suture placement. There is a “surgeon’s view” picture and a sagittal view in each figure. You can look at this as an animation if you use the page step function on your Microsoft Word program. Just view the steps as animation the first few times through. You can go on to read the text for each step once you have the animation down.

You may believe that the demands are over-precise. The point is that you can generate deep perfectly radial sutures equidistant from the wound if you follow these steps consistently. **Your final grade after session 4 is based on how well you approximate this goal.** Understand graphically what the needle and forceps are supposed to do at each step of the procedure. You already understand the concepts for stability and fine motor control. The wet lab will bring it altogether. Come prepared!



## STEP 1-1

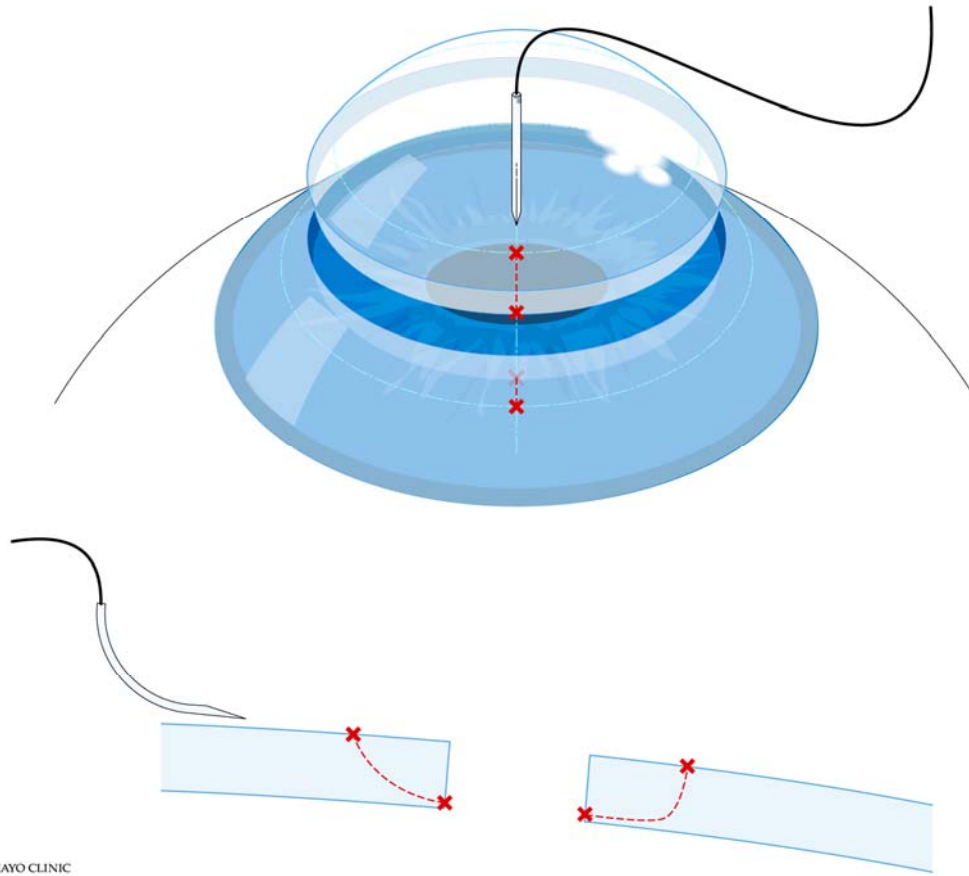
Visualize the entry and exit positions of the sutures relative to the graft and host. Every suture you will place should be the same distance from the graft edge and the host edge, should be radial, and should be deep. You must visualize this before you have any chance of achieving it.



## STEP 1.2

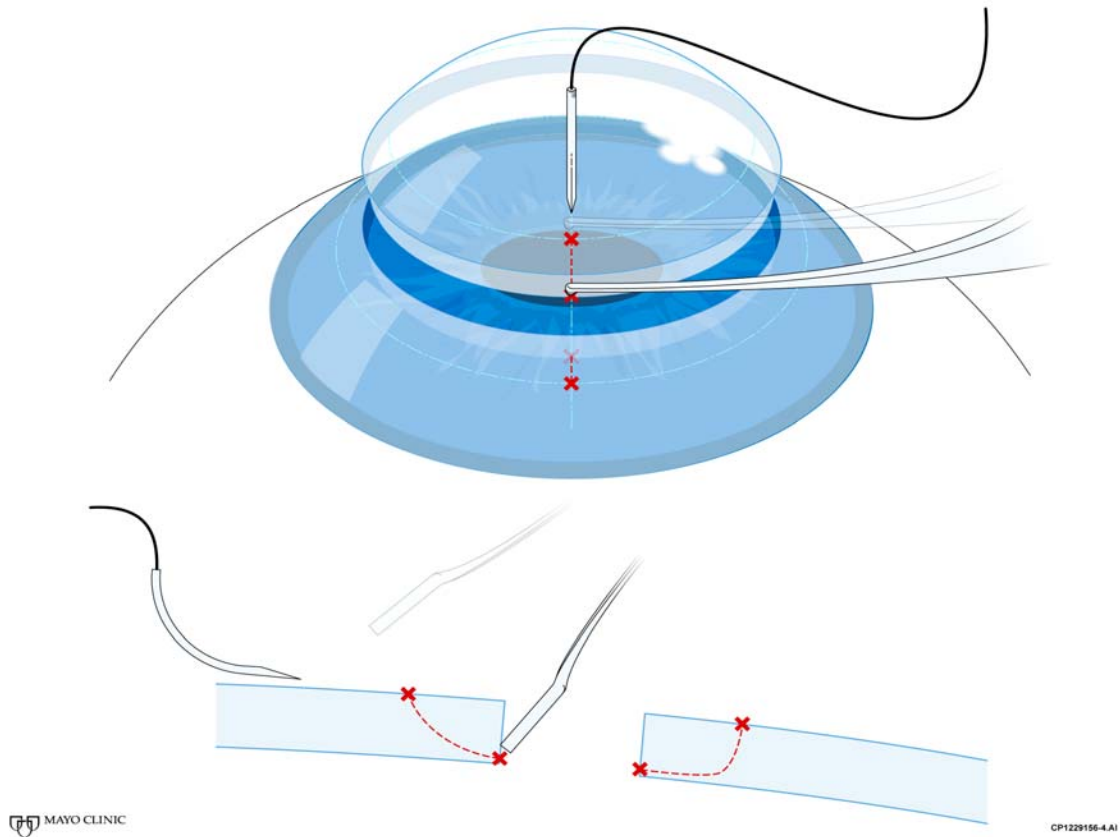
Place the flat of the needle parallel to the host surface.

We do this at the beginning because your hand should feel comfortable in this position at the start. Rookies find it is more difficult to pass the needle through the host tissue than the graft. Rookies find it much easier to do it if they start comfortable in the “needling host” position.



### STEP 1.3

Retract the suture centrally along the intended radial path of the suture. You will want to keep this position stable while you start to bring the forceps into position.



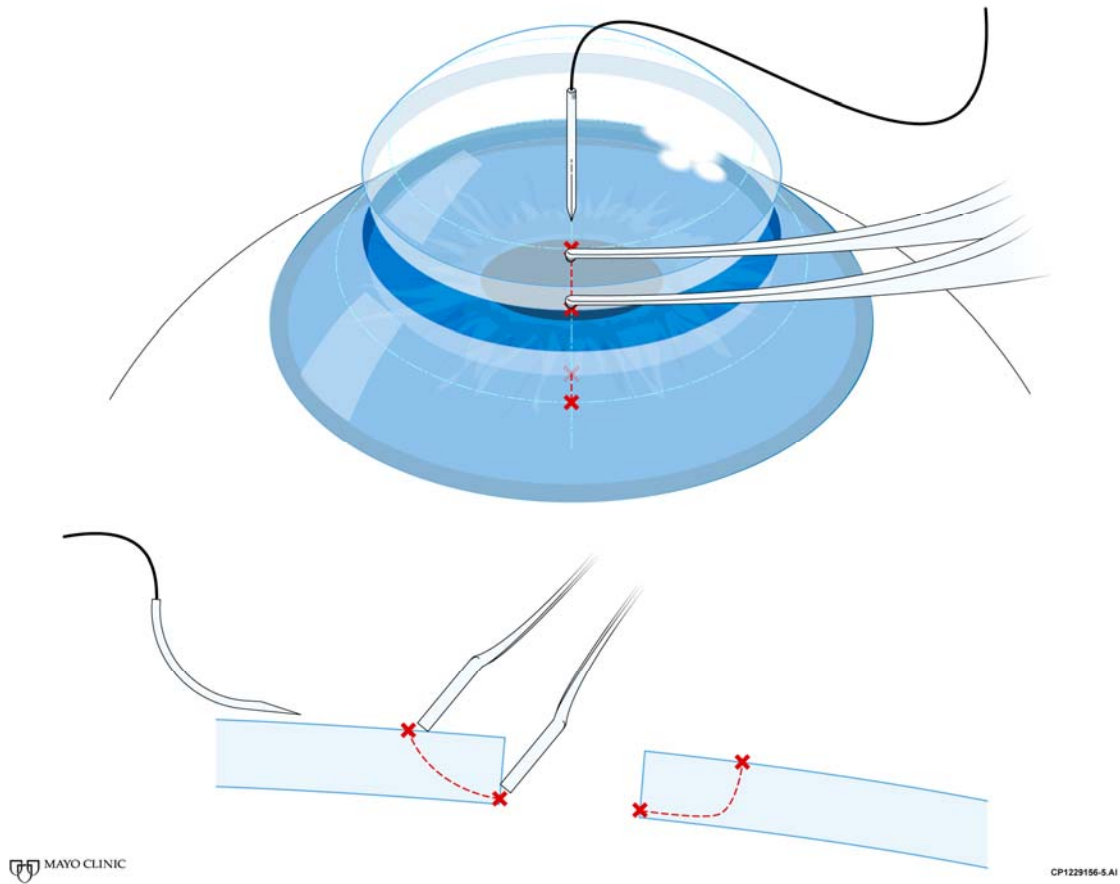
#### STEP 1.4

Engage the graft edge with the forceps tip just above the graft edge. Note the angle of the line that runs between the forceps tips. It is in position to grab the graft just peripheral to the intended site of needle entry into the graft.

#### NOTE:

An acute forceps angle will cause you to grab too close to the graft edge.

A flat angle will prevent the upper end of the forceps from grabbing the tissue. It will skip off the surface.



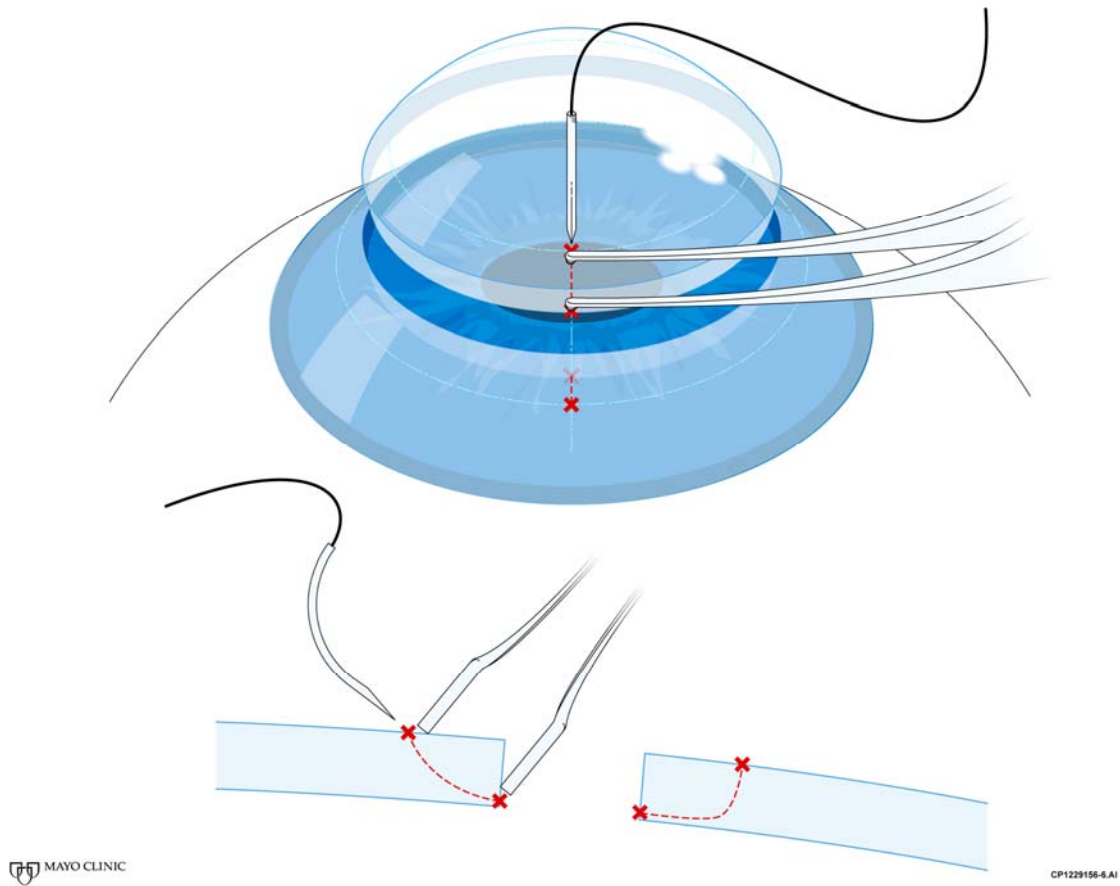
### Step 1.5

Forceps grabs the tissue.

#### NOTE:

You must keep stable the finger that controls the graft edge as the other end of the forceps grabs the top of the graft. If you don't do that, the graft edge will be distorted and the tissue will move out of its passive position. This is why you perform the fine motor exercises with the forceps before entering the lab you want to be equally comfortable stabilizing/moving the forceps tips controlled by thumb and forefinger.





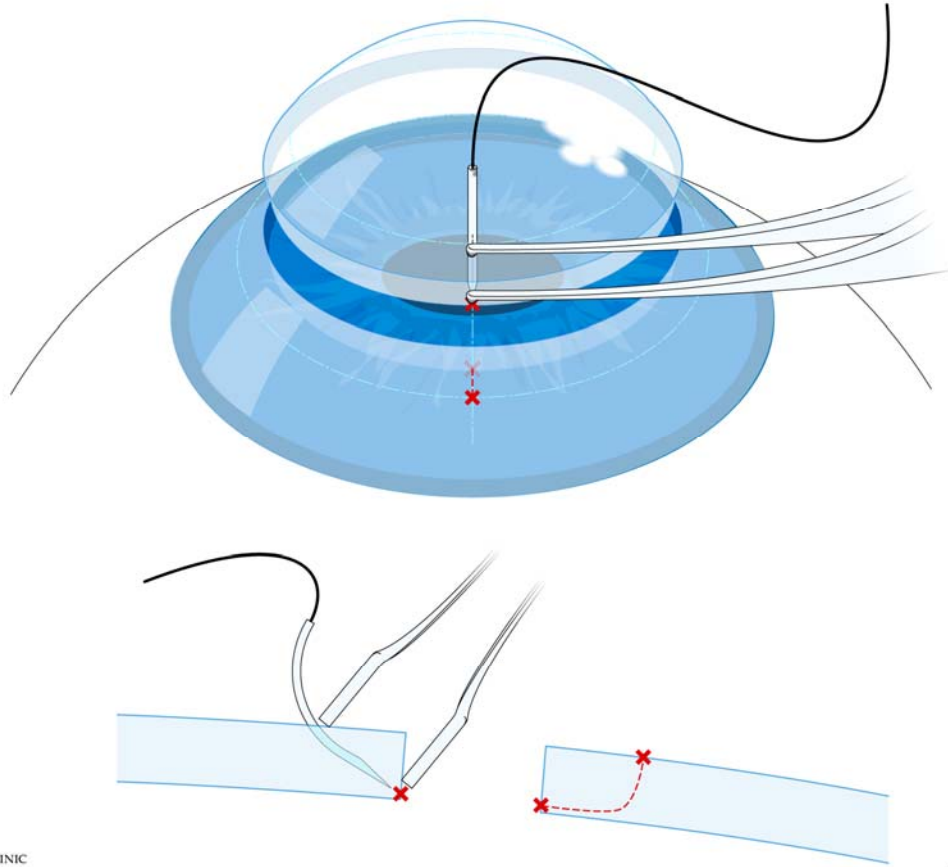
### Step 1.6

Point the needle so it will enter just central to the forceps tip on the host and will aim just under the forceps tip at the graft edge.

#### NOTE:

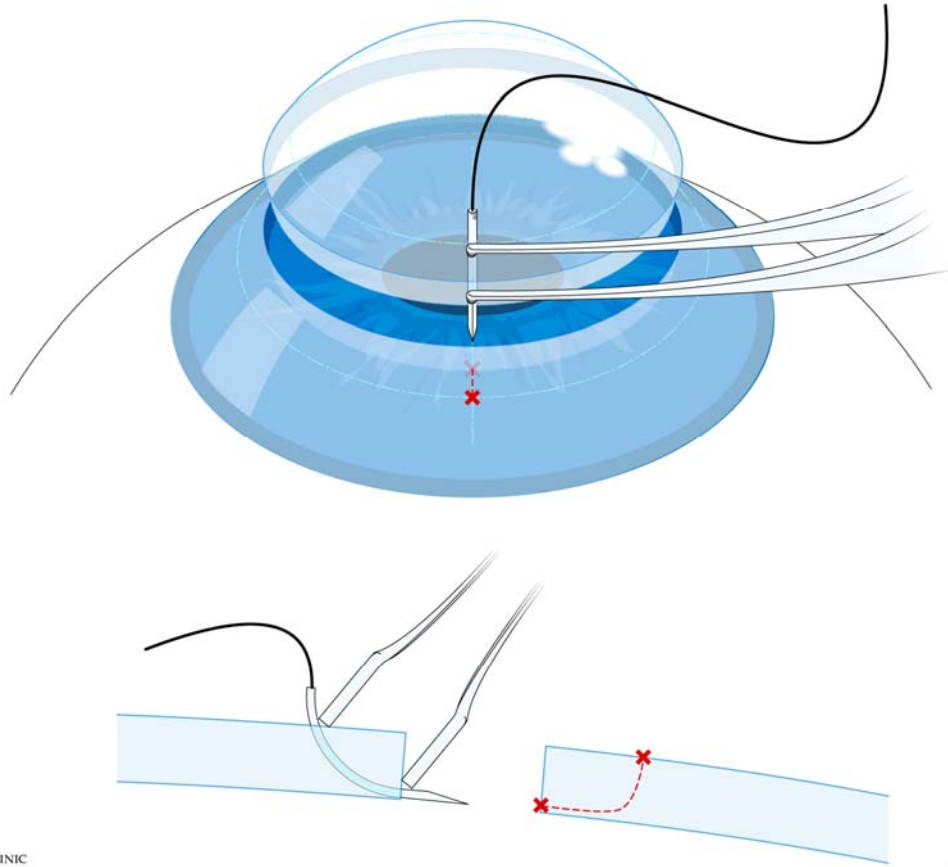
A too-flat angle will cause the needle to hit the forceps tip at the graft edge. It is your feedback that you are too shallow.

It is hard to make a too-steep angle.



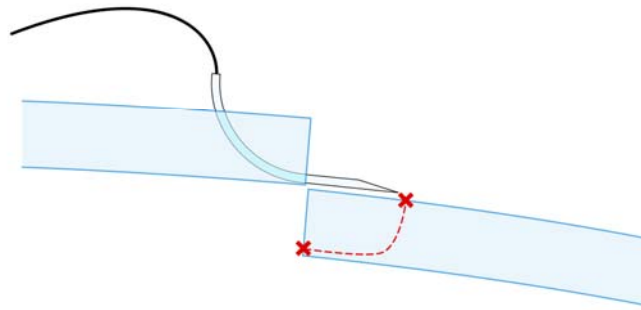
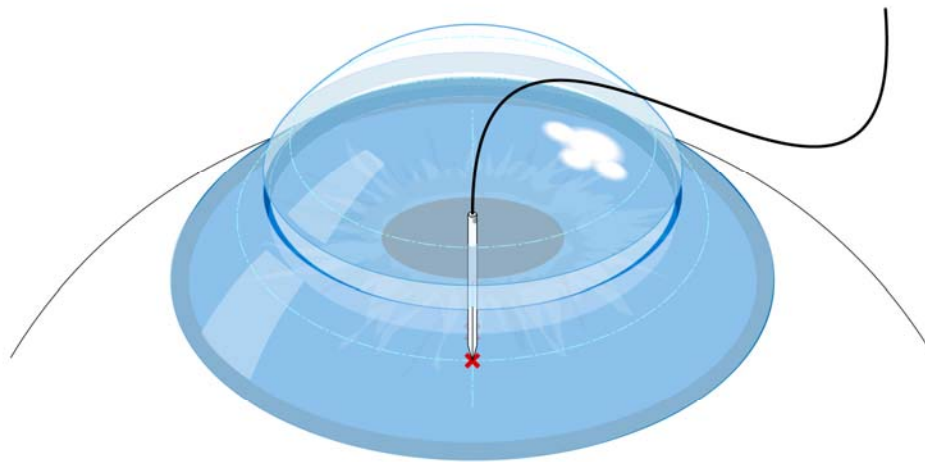
### Step 1.7

Drive the needle on a straight line. You don't have to do anything with your wrists or fingers because you already set up the instruments correctly. The needle will pass through smoothly and easily if your setup was correct. Make sure the forceps gives good countertraction.



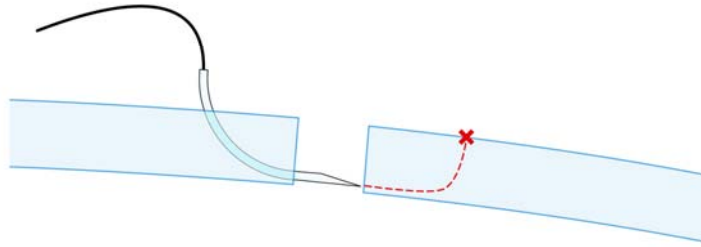
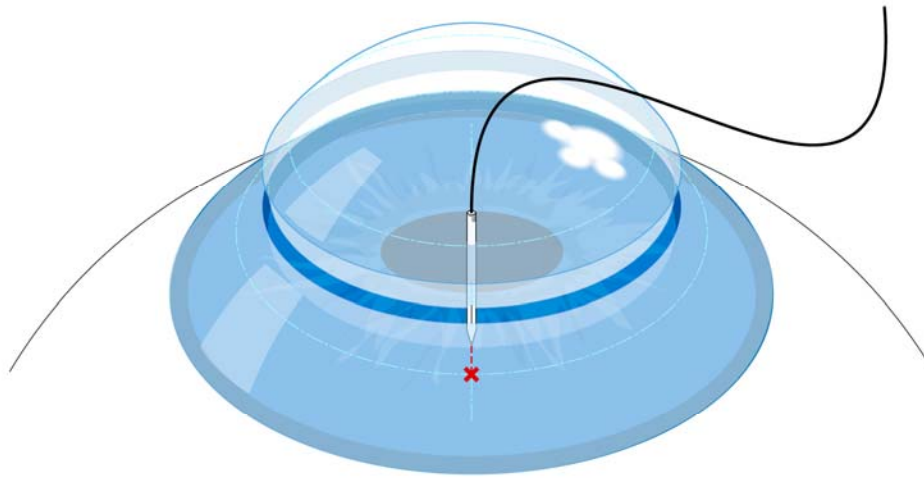
### Step 1.8

The needle should extend out of the flap edge for a distance equal to the distance you want it to go into the host cornea. Don't let go of the forceps until you have exposed the proper needle length.



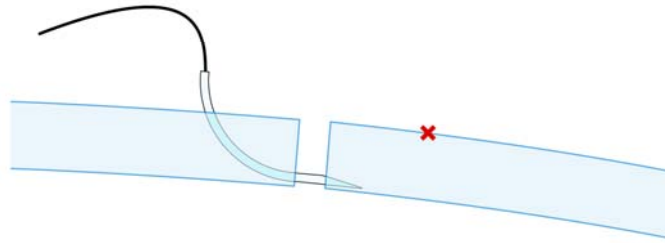
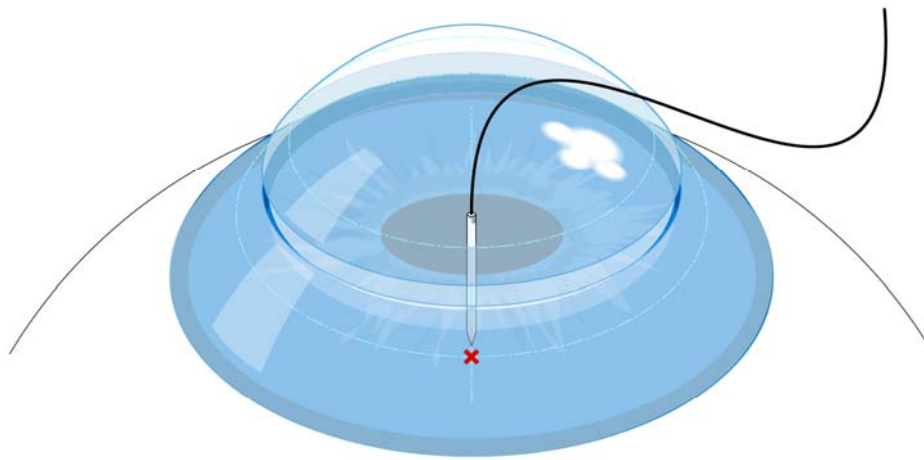
## Step 2.1

Place the needle on the surface of the host with the needle parallel to the host surface. The best way to make sure a needle inserts parallel to the posterior surface is to start off with it parallel to the anterior surface. Then make sure you keep an eye on the plane of the needle as you begin to walk it down the host edge.



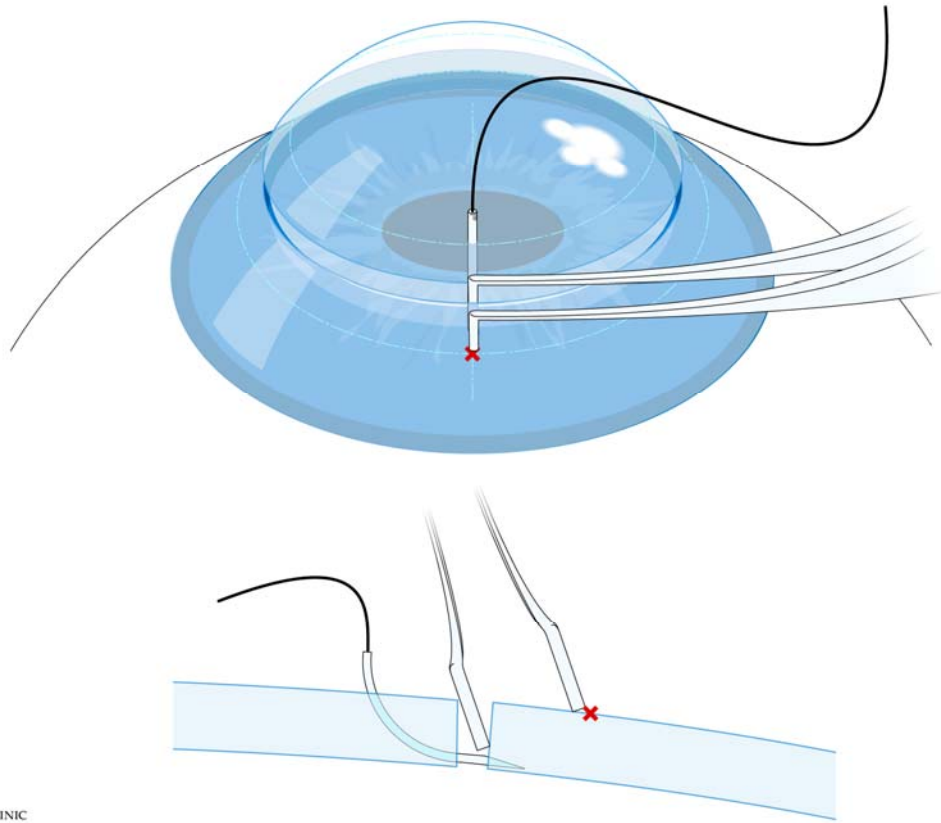
## Step 2.2

Maintain the parallelism and walk the needle down the wall of the host cornea until you believe you are deep.



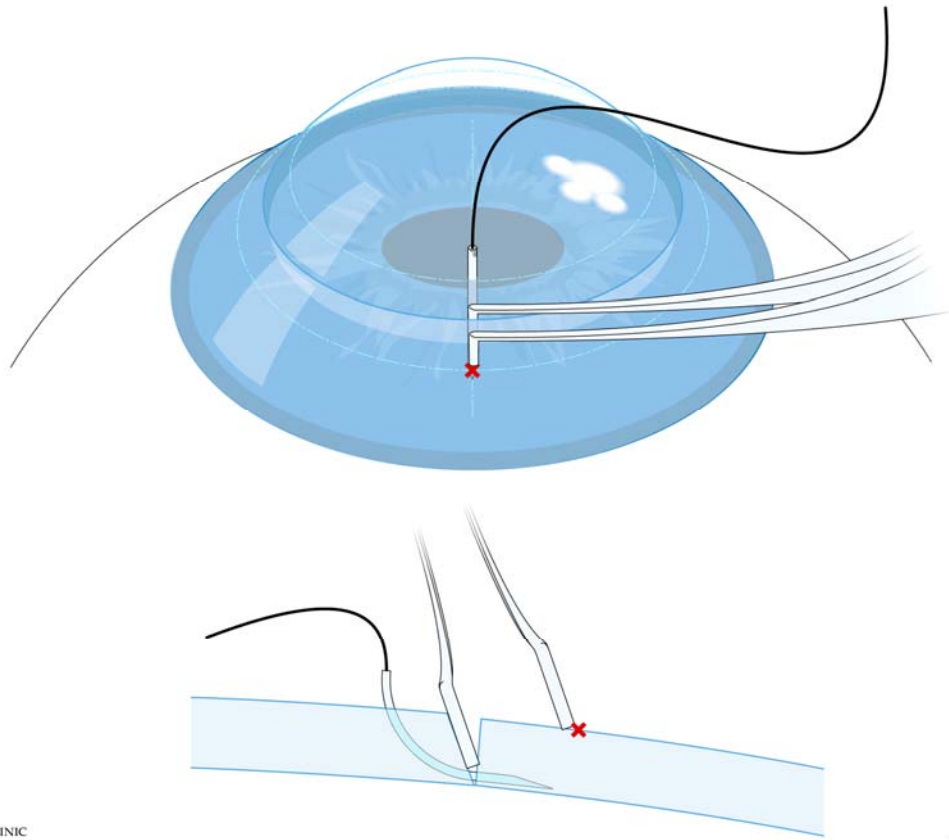
### Step 2.3

Insert the needle just a little. You are just getting a foothold until you can stabilize the host cornea with the forceps in the next step.



## Step 2.4

The tips of the forceps should be parallel to the line of the needle. The lower tip engages the corneal edge just over top of the needle-not to one side or the other. The upper tip engages just short of where your needle drive will end. Do this right and the cornea will not torque and the needle will always insert deep and parallel to the deep host line.

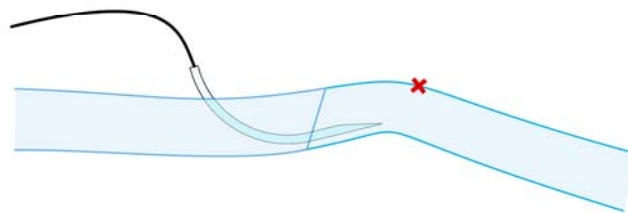
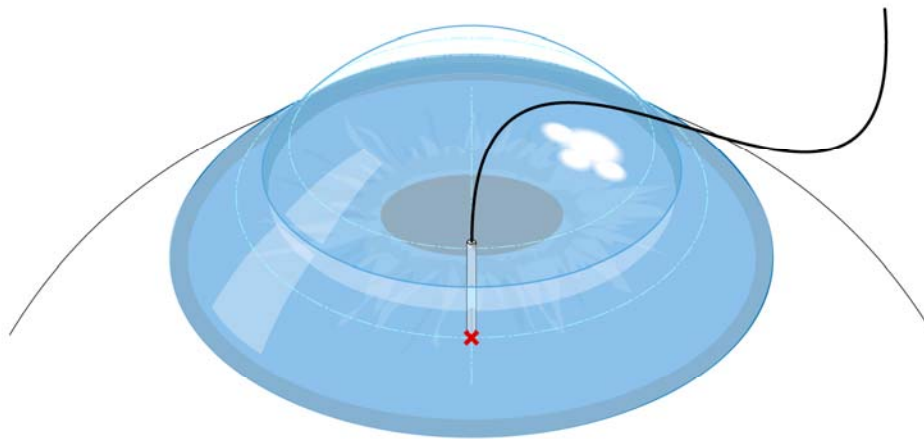


### Step 2.5

Drive the needle into the cornea and the cornea into the needle. The insertion is a simple straight push if your set-up was correct.

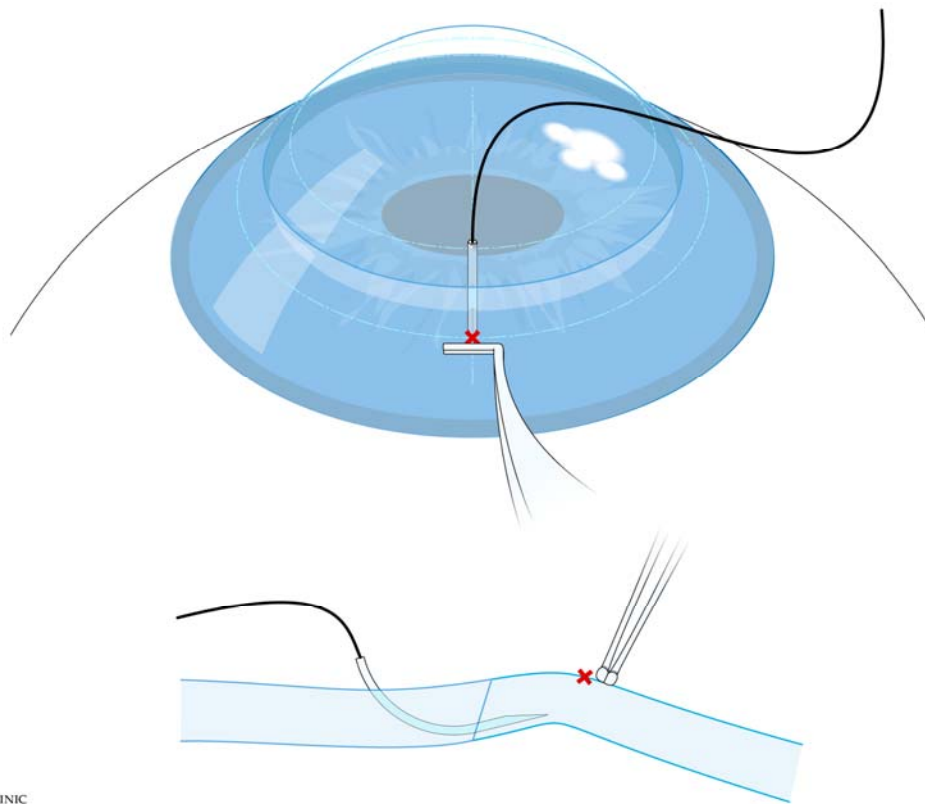
The cornea will tort if you do not have the forceps tips aligned along the line of passage.





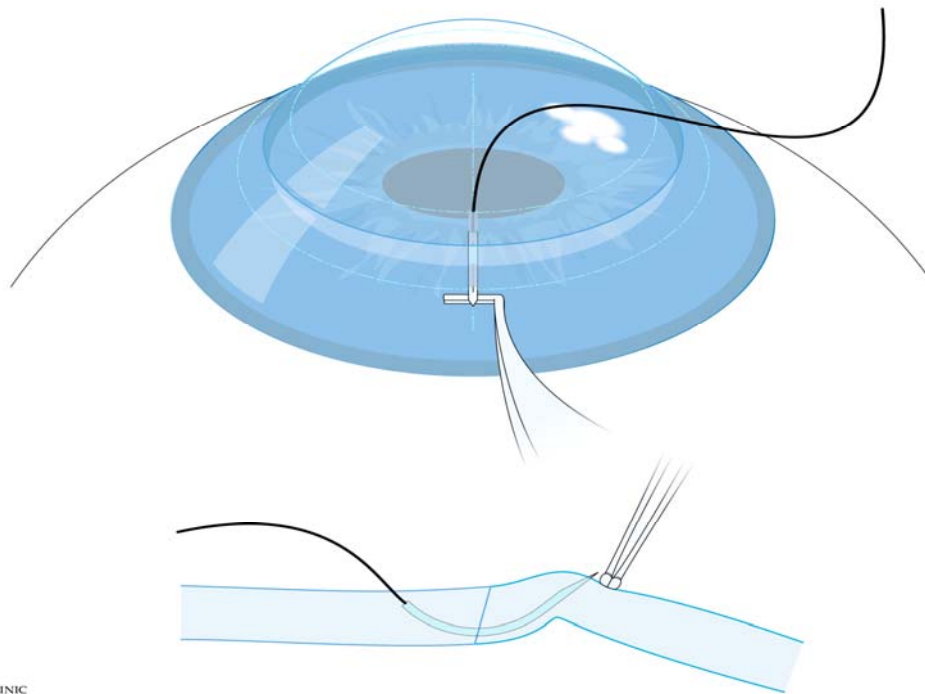
### Step 3.1

Rotate the needle up towards the proposed exit sight. The cornea will bend a bit.



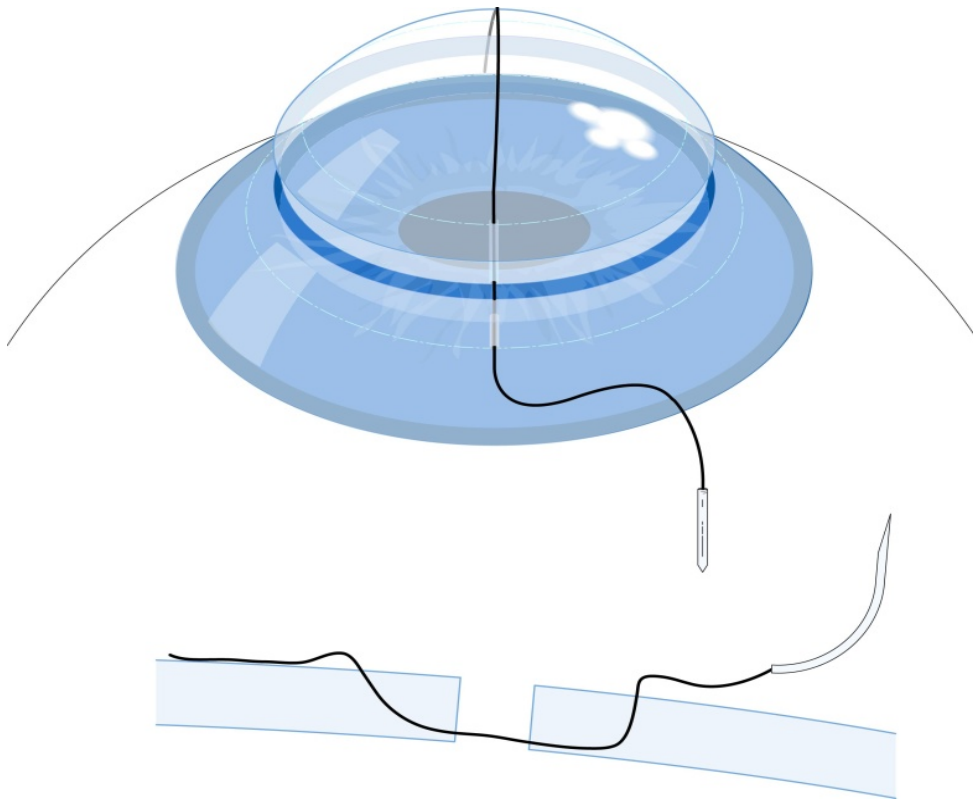
### Step 3.2

Place the forceps perpendicular to the line of the needle. Make sure the needle tip will exit in the very center of the flat of the forceps. The flat of the forceps should form a “T”-NOT an “L” with the length of the needle. The forceps should be fractions of a millimeter from the proposed exit site



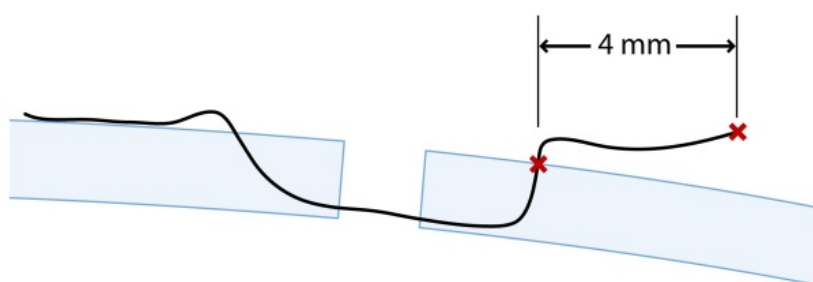
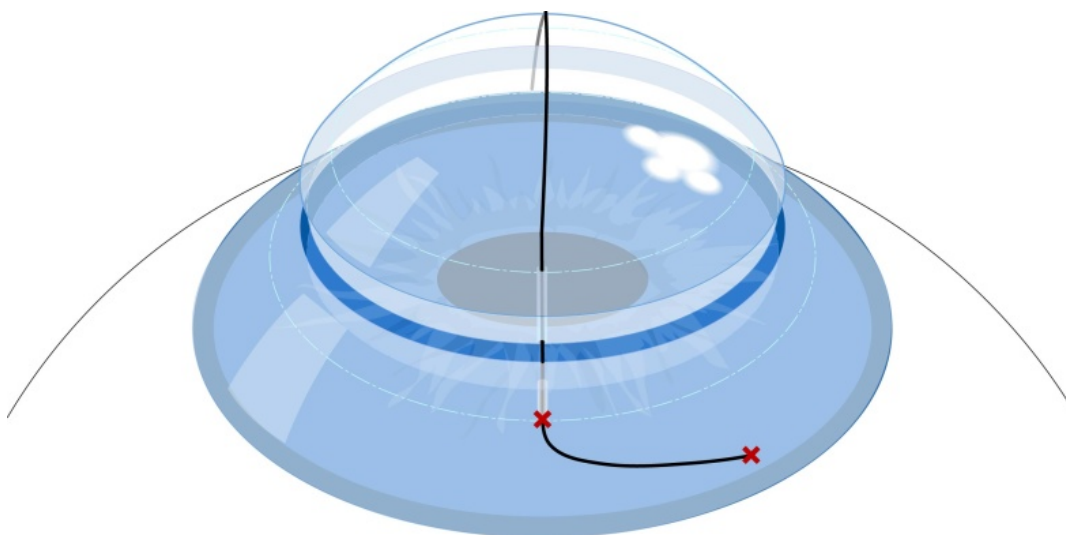
### Step 3.3

Hold the needle still Push down on the cornea and the needle will drive itself to the surface.



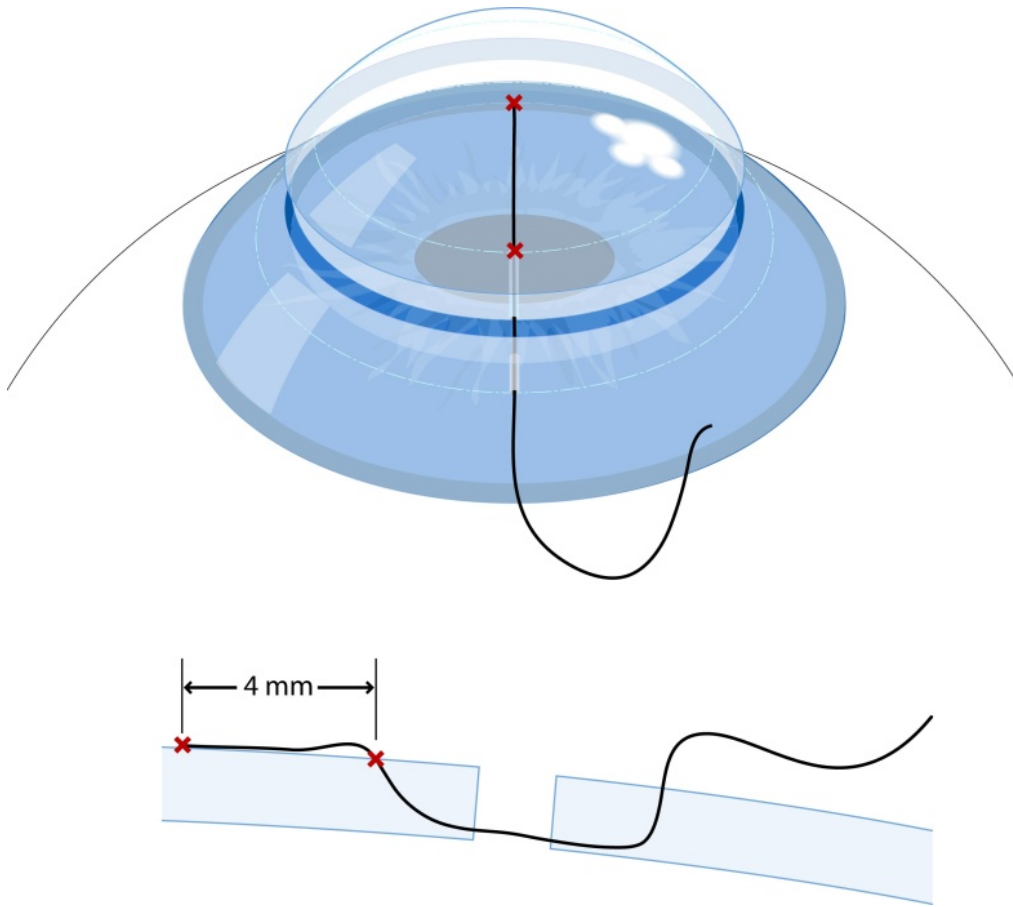
#### Step 4.1

Pull suture through wound parallel to wound until the end reaches the limbus opposite the wound



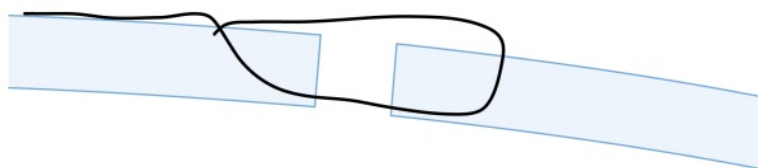
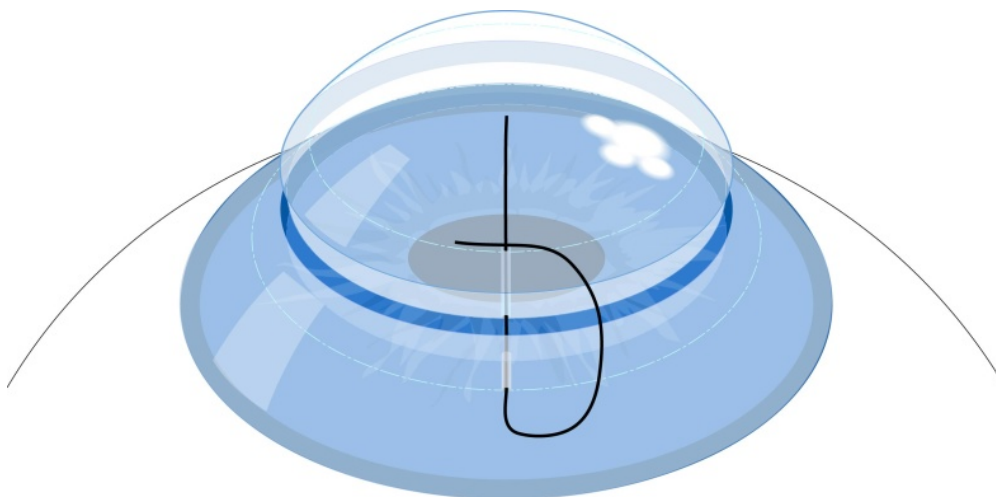
#### Step 4.2

Cut needle end to leave 4 mm at limbus near wound. You should now have enough suture to work with without having so much to make tying ungainly.



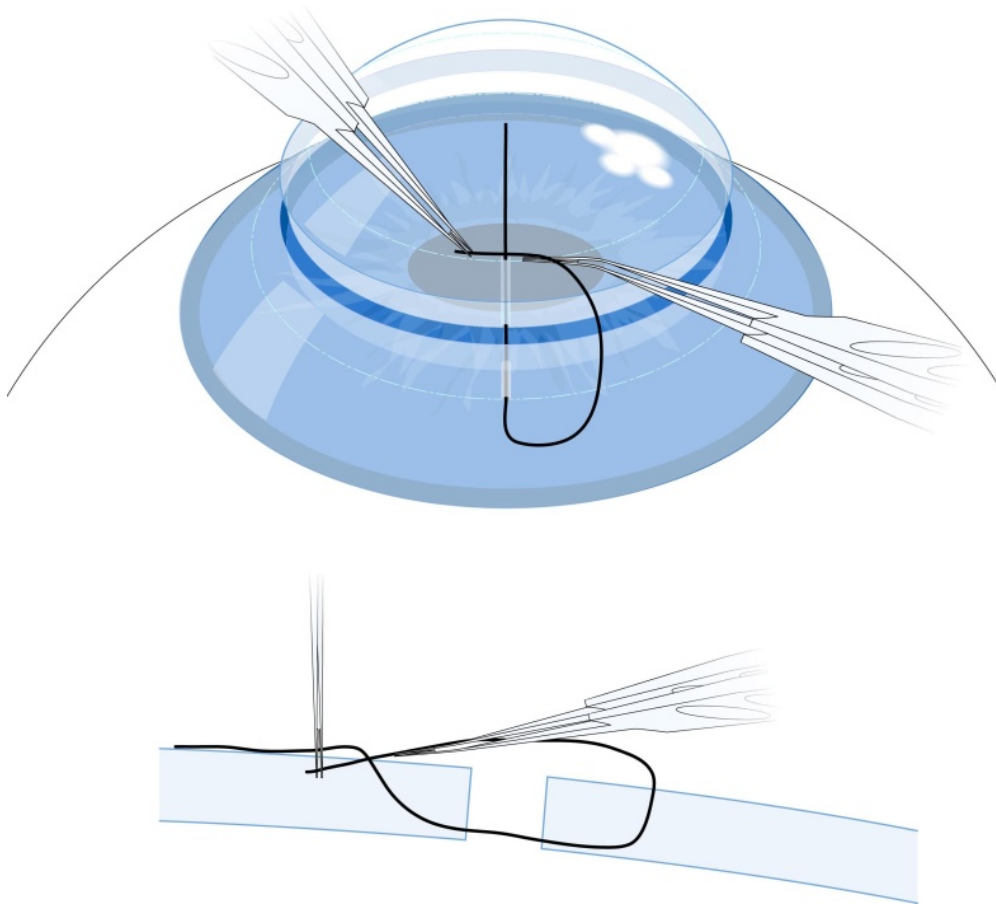
#### Step 4.3

Pull the suture through until 4 mm of suture remain on the graft side



**Step 4.4.**

Making the “T”. This is an important step for easy tying. Note all that is happening here. The long end of the suture crosses the short end at the point the graft suture enters the graft. The crossed end is perpendicular to the short end.



#### Step 4.5

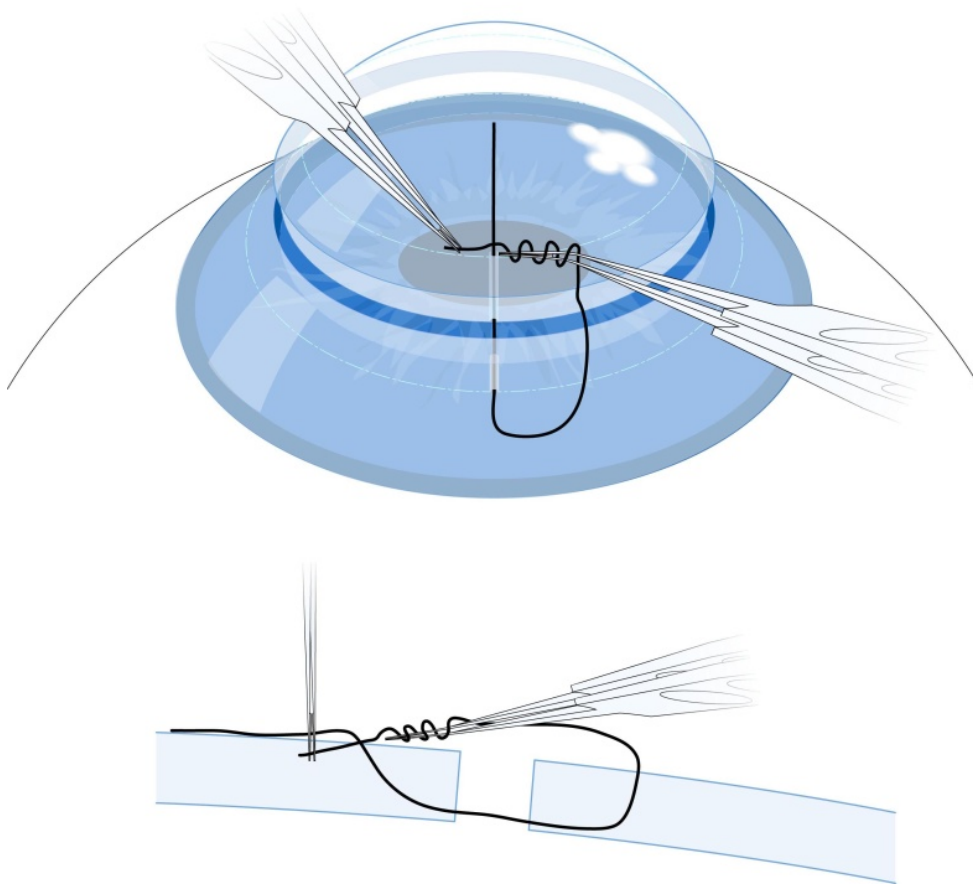
Instrument position. **VERY IMPROTANT TO DO ALL THINGS RIGHT.**

Straight tying forceps. **Perpendicular to the graft surface. The suture exits the forceps 90 degrees from the axis of the instrument.** You need this position to keep the suture straight. That makes it easier to loop over the curved forceps. The loops will also run up the curved forceps better leaving room for the next loop.

Curved tying forceps. **The forceps is parallel to the plane of the graft. It is to the right of the short suture. The tips are parallel to the line of the suture coming out of the straight forceps. The tips are near the insertion of the suture into the graft.**

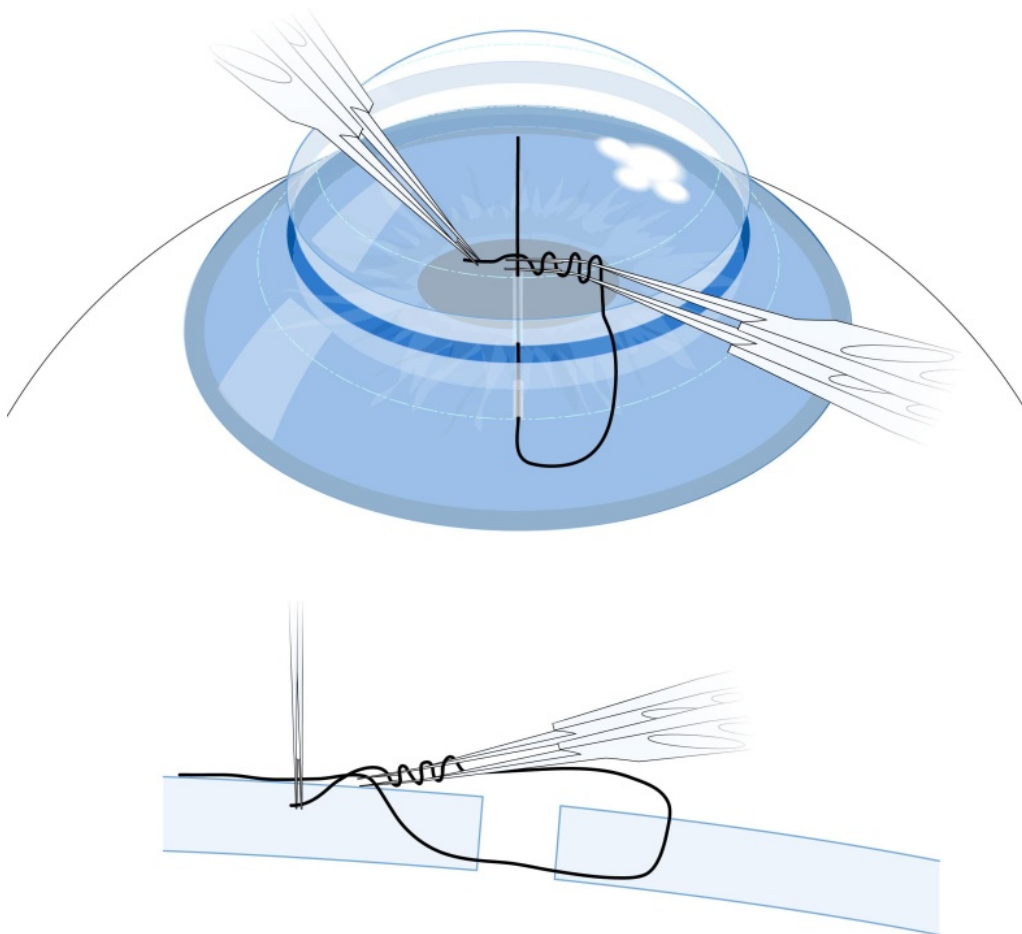
Why all this detail? The loops go up the instrument easier if the curved forceps is parallel to the line of the suture held by the straight forceps. You are more likely to have loops fall off the curved forceps if your looping position is to the left of the short suture and then you have to move the whole thing to the right to grab the short suture. You are more likely to have the short suture pull through the graft and lose the suture if you position the tips of the curved forceps near the end of the short suture and then have a tug on the loop.





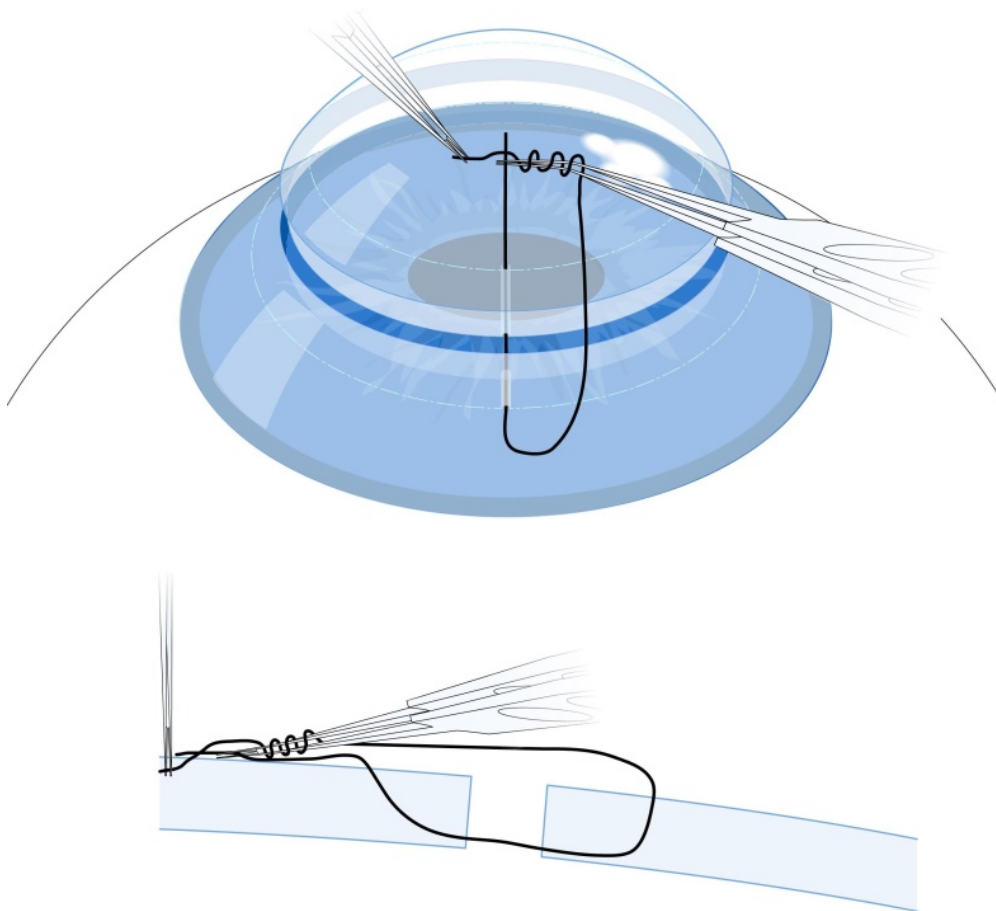
#### Step 4.6

Three loops on the first throw while maintaining all the instrument/suture positions shown in step 22.



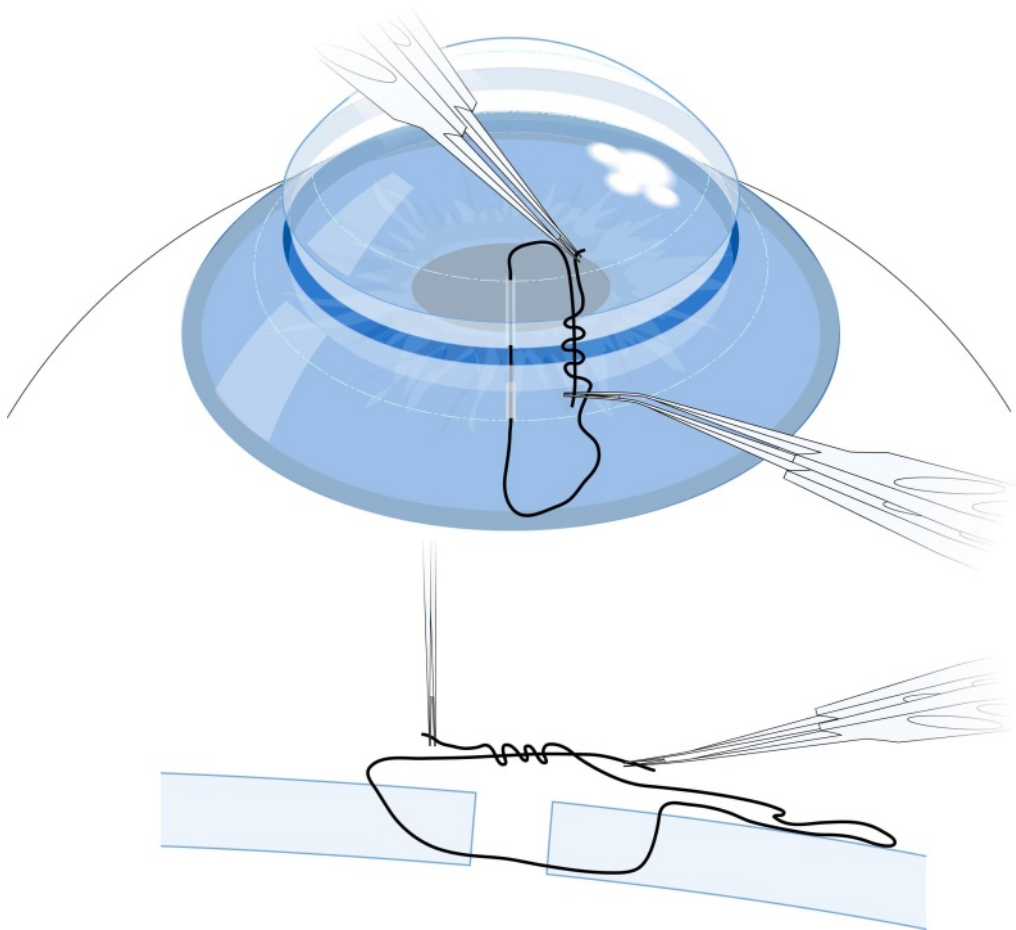
Step 4.7

Open curved forceps slides under short suture at suture's entry point into graft



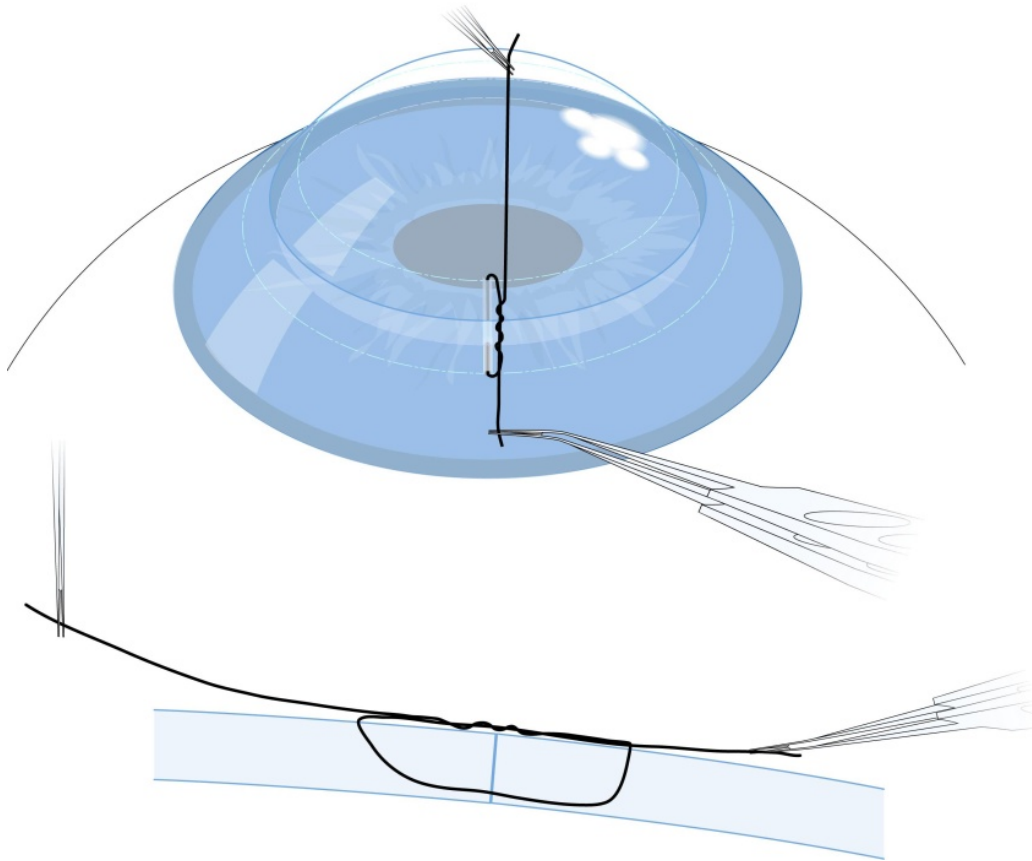
#### Step 4.8

Curved forceps slides up short suture to tip of short suture for grab.



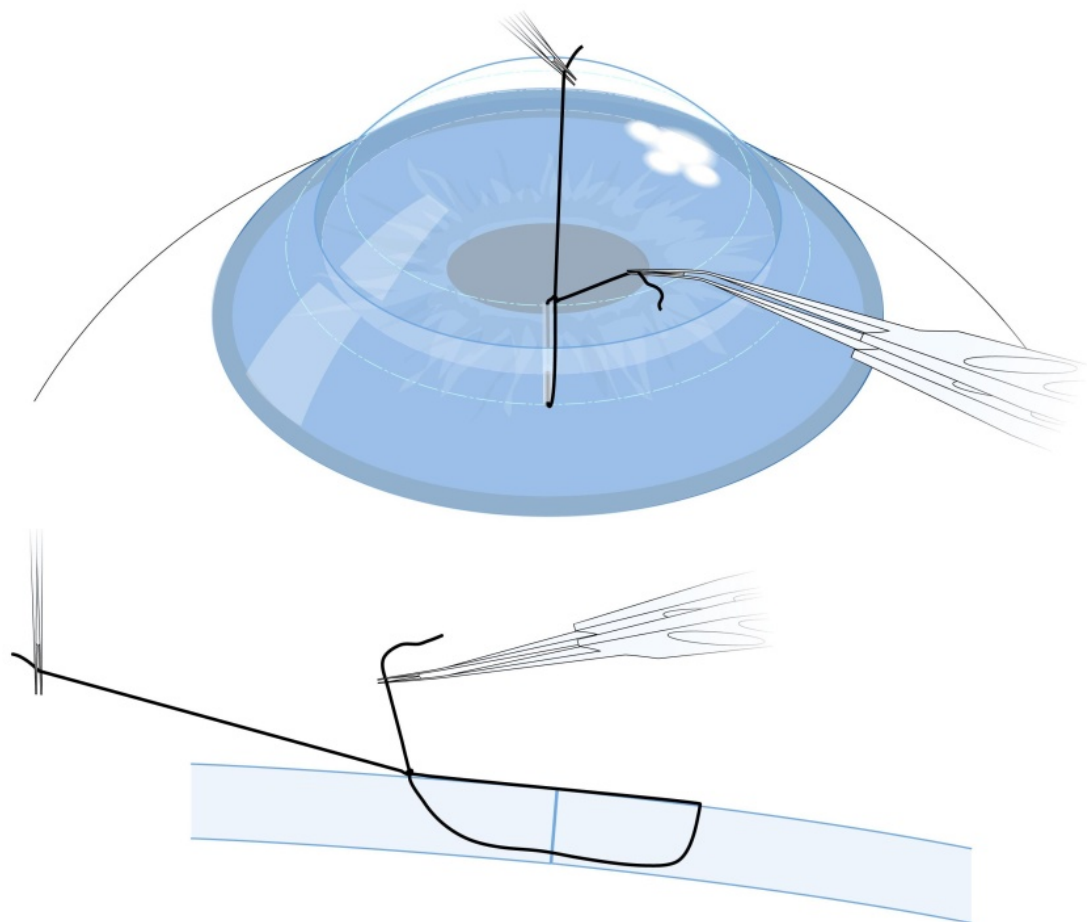
#### Step 4.9

Make looped suture parallel to the suture track through the cornea. You want to pull on the suture asymmetrically so that the suture end on the graft side is long and the end on the host side is short.



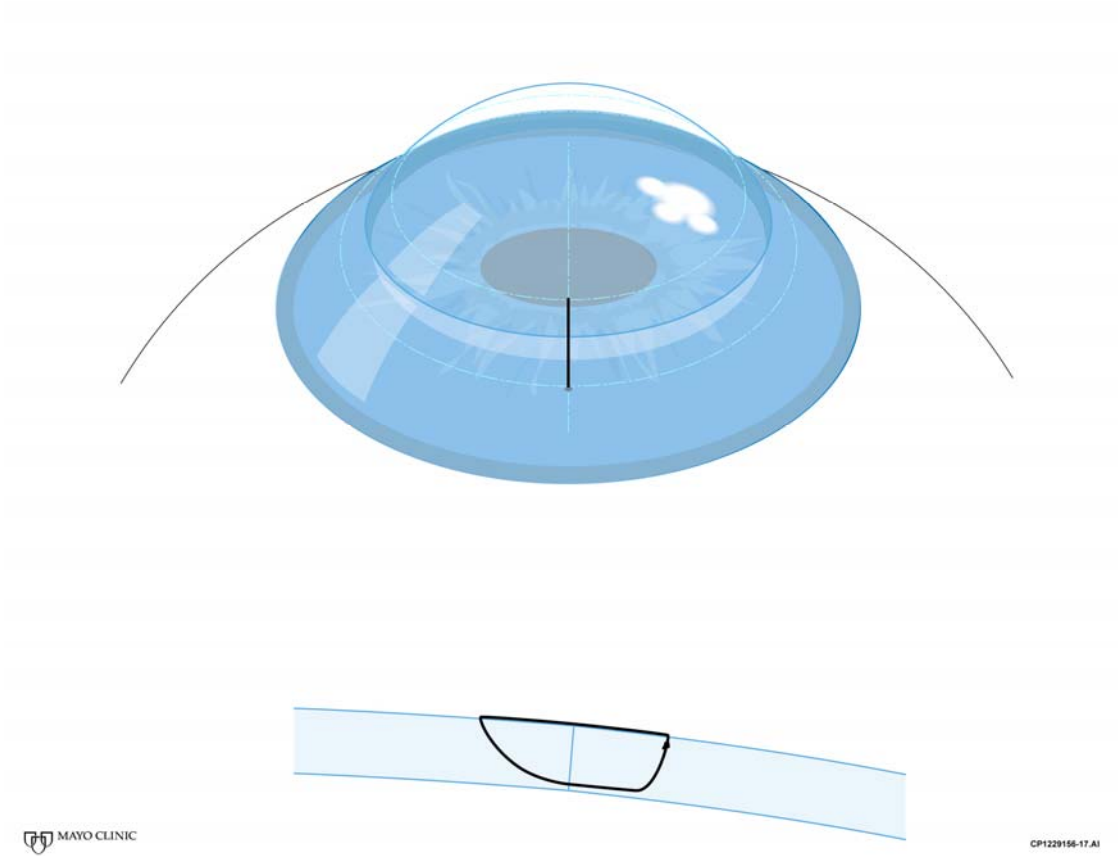
#### Step 4.10

You want to pull on the suture asymmetrically so that the suture end on the graft side is long and the end on the host side is short.



#### Step 4.11

The locking step. Keep tension on the long and short ends of the suture. Pull the short end to the graft side of the wound and pull until the loops in the first throw click into a tiny locked structure. Then throw two more loops to make a secure knot.



Final product

#### IV. WETLAB CHECKLIST

##### **Go to the lab prior to the surgery day and check on the setup**

- Talk to the lab people the week before the first lab session and **try to have one eye ordered** for the beginning of every scheduled session. It is also good to do a cornea on your own at a session between the consultant sessions.
- Read how to set up the corneas so that they are non-edematous prior to practice surgery. Hamaoui M et al. Corneal preparation of eye bank eyes for experimental surgery. Cornea 2001;20:317-320. The dextran works best if the cornea is dehydrated from both the anterior and posterior corneal surface. First inject it into the anterior chamber; then place the eye cornea down in a solution of dextran to dehydrate the anterior cornea.
- Make sure you know the names of all the instruments to be used in surgery.
- We will provide you with a straight and curved tying forceps and with a colibri forceps. You should pay particular attention to their maintenance and keep them separate from the general instrument tray.
- Other instruments include a Hesburg-Barron trephine, curved non-locking needle holder, curved Vannas scissors, three 25-gauge cannulas, and a 64 blade for marking the corneal surface.
- Other items include 2 packets of 10-0 nylon suture, a gentian violet marker, two 3ML syringes filled with water, a syringe with viscoelastic (or alternatively a 3 ml syringe filled with KY jelly), a beaker filled with water. And a tooth brush for instrument cleaning. Make sure all instruments are clean, cannulas patent, and the area is stocked with sufficient suture, Healon, and other supplies.
- Let us know right away if anything is in poor working order or if anything needs to be ordered.
- Make sure you follow universal precautions and good maintenance in the practice area



## LAB DAY ONE

### Setup

- The practice eye should begin dehydration with dextran **early in the morning.**
- Confirm that all instruments are present and working well. If any instruments are broken, call Dr. Maguire so he can bring temporary replacements for that day's session.
- Pressurize the practice eye
- Place the eye in the eye holder so that the **corneal plane is parallel to the floor**
- Dry the corneal surface
- Use gentian violet to mark the center of the cornea
- Place gentian violet along the length of the 64 blade. Use the spatula to make 8 equally spaced radial marks that extend from the center mark to the limbus. Press lightly. You want to make a fine mark so you can see the deeper cornea through it.
- Call Dr. Maguire to the lab when you are ready to begin the session and for the first session he will trephine the cornea.

## Lab 1 tasks in sequence

We start with the easiest maneuver to learn and ramp up to the finished product. Parts before the whole!

1. Observe staff pass 2 sutures.
2. Suture tying (4.1-4.11)
3. Learn how to identify depth of forceps tip by looking through cornea
4. Proper forceps grab on graft cornea around perimeter steps (1.4 and 1.5)
5. Proper forceps grab on host (step 2.4)
6. Proper hand position for needle holder
7. Proper hand position for grabbing suture
8. Place suture through host tissue (steps 2.1-3.30)
9. Place suture through graft tissue (steps 1.1-1.8)
10. Put it all together! Start at 1.1 and go consecutively to step 4.11.

# GRADING SHEET FOR PENETRATING KERATOPLASTY LAB

Name : \_\_\_\_\_

Date: \_\_\_\_\_

	12:00	1:30	3:00	4:30	6:00	7:30	9:00	10:30
<b>Host Length</b>								
<b>Host radial</b>								
<b>Host Depth</b>								
<b>Graft Length</b>								
<b>Graft Depth</b>								
<b>Graft Radial</b>								
<b>Compression</b>								
<b>Total Score</b>								

Additional Comments:

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## Grading Key

<b>Suture Length</b>	Notation	Suture length score
.8-1.2 mm	1	1
<0.8 mm	2	0
>1.2 mm	3	0

<b>Suture Radiality</b>	Notation	Radiality score
within 10 degrees of radial	1	1
> 10 degrees clockwise	2	0
>10 degrees counterclockwise	3	0

<b>Depth</b>	Notation	Depth score
>2/3 depth	1	1
1/3 to 2/3 depth	2	0
< 1/3 depth	3	0

<b>Compression</b>		
Taut with no wound mounding	1	1
Slack	2	0
Taut with wound mounding	3	0

