Complicated Corneal Ulcers

*Microbial Keratitis*

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**Learning Objectives**
- Recognize the signs of corneal infection
- Recognize the signs of corneal melting
- Understand the diagnostic and therapeutic options.

**Introduction**
A corneal ulcer is an area of the cornea that has lost its epithelium and a variable amount of stroma. Stromal ulcers take longer to heal than simple epithelial abrasions. Uncomplicated stromal ulcers that were trauma induced should heal in one to two weeks; as opposed to superficial corneal abrasions that should be healed in less than one week.

**Definition**
A complicated corneal ulcer is one that has additional factors present which are not only delaying the normal healing response but have the potential to cause further deterioration of the cornea. These factors can be intrinsic or acquired. Sepsis is the most common acquired reason which can directly destroy the cornea as well as by stimulation of intrinsic "self destruct" mechanisms (collagenase). In addition, other complications of septic ulcers are uveitis and cataract.

**Epidemiology**
Even though corneal ulceration is one of the most common ocular disorders in dogs; the incidence of complicated corneal ulcers is not known but is felt to be significantly less than uncomplicated corneal ulcers.

**Etiology**
In most cases the cause is corneal trauma, however considerations of foreign body, eyelid abnormalities, aberrant cilia, exposure and KCS (keratoconjunctivitis sicca), should be made.

**Normal Corneal Defense Mechanisms**
Normally the cornea is flooded with microorganisms consisting of the normal flora. Normal corneal defense mechanisms provide protection from these organisms.
- Eyelids and intact blink reflex
- Eyelashes
- Reflex tearing and trilaminar tear film
- Tear proteins with antibacterial effects
- Microbial products (bacteriocins) from the normal flora that affect pathogenic microorganisms
- Corneal epithelial cells
- Smooth corneal surface
Impaired Corneal Defense Mechanisms
When any of the above normal protective mechanisms are not present or if they are malfunctioning; there is increased risk for infection. In addition, specific risk factors such as trauma, foreign body, corneal surgery and other local or systemic factors can impair the normal corneal defenses. Microorganisms may adhere to the corneal tissues more readily if there is damage to the tissue and / or if the microorganisms are not swept from the surface of the cornea efficiently by the normal blink, and tear film mechanics and physiology. Systemic factors such as senility, Cushings disease, diabetes mellitus, and any other local or systemic disease or medication can impair the immune system.

Clinical Features
The evaluation of an animal with a stromal keratitis should include a careful history and examination of the corneal ulcer for signs of infection as well as the entire anterior segment to look for predisposing factors. Most often the history is one of an initial acute onset of ocular discomfort, blepharospasms, tearing and rubbing at the eye. Examination findings that would imply a complicated stromal ulcer and possibly a microbial keratitis:

- Corneal ulcer present longer than one week with stromal loss
- Progressive stromal loss
- Infiltrate
- Neovascularization - perilimbal flush
- Anterior uveitis
- Soft borders
- Malacia (melting) = liquifactive stromal necrolysis
- Small ulcer (pin point or dot), minimal to no apparent stromal loss, acute onset with significant anterior uveitis (miotic pupil and aqueous flare and pain)
- Hypopyon
- Corneal edema

Sterile complicated stromal ulcerations are frequently encountered and usually do not have infiltrates or hypopyon; however they may be malacic and have secondary uveitis.
Four Steps For Success when dealing With Complicated Stromal Ulcers

STEP 1

Attempt to determine the cause for the stromal ulcer and inspect the anterior segment

Ophthalmic Examination (Especially take note of the following points)

- Location of ulcer
  - Axial
  - Paraxial
  - Inferior nasal
  - Inferior temporal
  - Perilimbal
- Size
  - Of the lesion is important especially from a prognostic standpoint.
- Shape of the lesion is important to note prognostically in that as the lesion heals one can identify the change in shape with healing, which is usually in the form of tongues or waves of epithelium moving toward the center.
  - The shape may also infer or corroborate the etiology; e.g., scratch would be linear or outline the path of a foreign body attached to the underside of the eyelid and the path or track it makes in the cornea as the eyelid moves.
- Palpebral Reflex
- Globe size and position
- Schirmer Tear Test (Do not perform if Descemetocèle)
- Eyelids (conformation, aberrant cilia)
- Foreign body search
- Evaluation for uveitis
- Intraocular pressure measurement (do not perform if ulcer is very deep and there is impending rupture)
- Is this ulcer infected?
  - Infiltrates
  - Indistinct borders
  - Grey to yellow color
- Is a foreign body present?
- Evert all eyelids and examine the conjunctival surfaces and fornix with magnification and good light
- What is the depth of the ulcer? (Amount of stroma remaining at its deepest point)
- What is the breadth of the ulcer?
- Are there other complications: Uveitis, Cataract, Glaucoma

Essential Examination Equipment

- Loupes
- Focal Light Source
- Slit Light Source
- Schirmer Tear Test Strips
- Delicate 1 x 2 rat toothed forceps
- Muscle hook
- Tonometer (do not measure IOP if there is a deep corneal ulcer).
### STEP 2

**Laboratory Evaluations**

- Microbiological Evaluation
  - Bacteria (dogs and cats)
    - Culture
  - Viral (cats)
    - IFA / PCR Herpes

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<td>❑ Diff-Quick or Wright Giemsa Stain</td>
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While the culture is pending and if the cytology result is:

1. **Suppurative with Sepsis:**
   - Cocci
   - Rods
   - Both
   - Hyphae

   Treat as if both cocci and rods are present even when either, both or no organisms are seen.

   Look for secondary problems such as Cushings Disease, Diabetes, topical / systemic steroid or cyclosporine usage, neoplasia, etc.

2. **Suppurative - no organisms seen on cytology:**
   - Sterile Melt
   - Septic but could not see organisms on cytology
   - Septic but no growth (in adequate sample, dead on arrival to lab, was septic but sepsis cleared, fastidious, anaerobe, viral, etc.)

3. **Non-suppurative/non septic**
   - Evaluate depth of ulcer
   - Evaluate breadth of ulcer
### STEP 4

#### IF THE DEPTH OF THE CORNEAL ULCER IS

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MEDICAL THERAPY SPECIFICS

Typically infected (septic) corneal ulcers can have either cocci or rods, or both; septic ulcers are usually of an aerobic variety. Because the infected cornea can melt down to a full thickness perforation rapidly; one can not wait for culture and a sensitivity result to return before an antimicrobial decision is made. With this in mind, the antimicrobial choice needs to have a great likelihood of being effective. Many of the traditional commercially available drugs (neomycin, bacitracin, gramicidin, and polymyxin b) are not as likely to be effective. Therefore one needs to choose drugs that have a greater potential for efficacy; unfortunately, many of these drugs are not commercially available as an ophthalmic preparation. Therefore special topical preparations of antimicrobials that have greater efficacy must be prepared.

Not all antibiotic preparations can be used topically. The list and recipes that follow cover a wide range of antimicrobials. Formulations below were taken from the UW VMTH Pharmacy; Don Michalski, RPh.

**Special Antimicrobials:**

**Amikacin**
Add 500 mg / 2 ml of Amikacin [Amicacina solution 25% IV solution] to 13 ml of Artificial Tears to make concentration of 33 mg/ml. Do not use Tears Naturale (precipitates). Expiration = 1 month

**Cefazolin**
Add 500 mg / 1.5 ml of Cefazolin (330 mg/ml) to 13.5 ml of Artificial Tears. Exp. = 7 days. Refrigerate. Shake well. The final concentration is 33 mg/ml.

**Gentamicin**
To make 9 mg/ml final concentration, add 35 mg (0.35 ml of the 100 mg/ml injectable) to 5 ml of gentamicin ophthalmic solution. Exp.: 1 month.

**Insulin**
Remove 2 ml from Artificial Tears bottle. Add 200 units (U100 - 2 ml) regular insulin. Final concentration = 13.5 units / ml. Exp. = 1 month Refrigerate

**Penicillin GK (Penicilina G)**
Remove 5 ml from 15 ml Artificial Tears bottle. Add 12 ml sterile water to 20 million unit vial of Penicillin GK (concentration = 1 million units per ml), add 5 ml Penicillin GK to 10 ml Artificial Tears. Final concentration of Penicillin is 333,333 units/ml. Exp. = 7 days. Refrigerate. Shake well.

**Tobramycin**
To make 9 mg / ml, add 40 mg / ml of Tobramycin injectable to 5 cc of Tobramycin ophthalmic solution. Exp. = 1 month.

[Use Methylcellulose 1% for Artificial Tears Unless Otherwise Indicated]
Antimicrobial Application Suggestions
All of the above drugs are in drop form (solutions). One or two drops of the solution can be used at each dosing interval. The dosing interval for bacterial stromal keratitis usually begins at one to two drops every 30 minutes for the first 24 hours. If improvement is noted after 24 hours, the frequency can persist for another 12 - 24 hours or begin to taper by 1/2 (if q 30 minutes then go to q 1 hour - if q 1 hour then go to q 2 hours).

Topical application to mimic subconjunctival injection can be done by instilling one drop / minute for 5 minutes each hour. When two or more different drugs are being used; they must be instilled at different times - at least 5 to 10 minutes apart since the lacrimal lake in the dog and cat can not accommodate more than one drop at a time.

Space for NOTES
**Anti-inflammatory Therapy**

Anterior uveitis is commonly associated with corneal irritation because when the cornea is abraded, factors are released (substance P and likely others) from the ophthalmic branch of the 5th nerve in the cornea. These factors enter the anterior chamber and cause the release of prostaglandin / leukotrienes, which generate the signs of anterior uveitis; break down of the blood aqueous barrier, vasodilatation, leakage of protein, smooth muscle contraction-ciliary spasm and the respective resulting pain and miosis.

Topical or subconjunctival steroids would be contraindicated yet topical and/or systemic anti-inflammatory drugs such as one of the nonsteroidal agents would be indicated.

1% Profenol  Suprofen: one drop 2 - 3 times per day  
Too frequent usage will cause a punctate keratitis and may also reduce corneal neovascularization

Buffered Aspirin:  10 mg/kg twice daily PO  
Vomiting or GI bleeding could occur in some patients - discontinue if these signs occur.

1% Atropine Sulfate ophthalmic solution or ointment:  
(not necessary in every patient with a stromal corneal ulcer)  
In patients with active anterior uveitis and no concern about glaucoma or KCS, atropine is helpful to prevent pupil seclusion and occlusion by means of mydriasis. Atropine also provides a degree of ocular comfort because it blocks painful ciliary spasms.  
Use with caution in animals predisposed to glaucoma since atropine narrows the ciliary cleft.

**Anticollagenase and Antiprotease Agents**

**Serum or Plasma**

Anticollagenase/protease agents are available to counter act collagenase and protease. The most physiological agent is the animal's own plasma or serum normally containing antiprotease and alpha 2 macroglobulin that are anticollagenase and antiprotease. Serum or plasma also contains the animal's immunoglobulins, fibronectin, and possibly other factors that have not been identified that are important in corneal defense and healing.

A blood sample can be collected in an EDTA or Heparin sterile blood tube or allowed to clot in a sterile red top blood collection tube. After centrifugation the resulting plasma or serum can be carefully drawn off and ideally passed through a (0.22-micron) Millipore filter into an empty sterile multi-dose injection vial. One-milliliter syringe-fulls can be aseptically drawn off and kept refrigerated. The serum or plasma can be dripped on to the eye directly out of the syringe. Do not keep a volume being used larger than one milliliter in a syringe to avoid contamination. The vial can serve as a storage reservoir; about 2 days.

The frequency of application is usually from once every 30 minutes to 8 times per day.

Care should be taken in handling this product since it could become contaminated easily.

**Acetylcysteine (Mucomyst®)** is a commercially available anticollagenase agent that has been successfully used as an extra label use drug in the eye. A 5% concentration diluted with an artificial tear such as 1% methylcellulose (Isoptoalkaline) can be used. Greater concentrations are more
irritating. A serous collagenase corneal ulcer should be treated hourly with the 5% Mucomyst drop at least for the first 6 to 12 hours. Tapering of the frequency can occur as deemed necessary.

EDTA can also be used to inhibit the proteoglycan enzyme produced by pseudomonas. A topical preparation can be made by adding 0.4 ml of EDTA (150 mg/ml) to a 15 ml bottle of Adapt or other artificial tear solution. One to two drops can be delivered five times daily (Bistner).
Since the cornea has a limited thickness, stromal corneal ulcers may deepen to the point where rupture of the cornea is imminent (less than 1/4 of corneal thickness remaining). It is at this time where procedures to provide structural support are necessary. The choices are conjunctival flaps (grafts), Autogenous lamellar corneal grafts (transposition of adjacent cornea), Tectonic corneal graft (frozen corneal tissue), corneal transplant (penetrating keratoplasty) and Cyanoacrylate repair.

Conjunctival flaps also provide an immediate blood supply that can deliver constituents vital to corneal healing via its blood supply.

**Principles**

**Conjunctival grafts or flaps**

These grafts should be as small as possible while still covering the lesion. They also should be thin and carry a blood supply so they remain viable, and they should have no holes (for a watertight seal) nor should they be under tension (to prevent dehiscence).

Several conjunctival flaps (graft) configurations are possible. The choice depends on the surgeon’s preference, experience, the condition of the cornea, and the size, depth and location of the corneal defect.
Conjunctival flaps must be applied with the subconjunctival surface directly against the stroma or Descemet's membrane to create a permanent adhesion. If the mucosal surface contacts the epithelium, stroma or Descemet's membrane, a secure adhesion probably won't develop. Also if the subconjunctiva is sutured to corneal epithelium, a poor adhesion can be expected; adhesion will occur only at each suture site, which would not be strong enough to hold the graft in place. Debriding the epithelium for about 1 to 2 mm around the margin of the corneal lesion will ensure that the flap adheres to the cornea. This is especially true in cases in which the corneal epithelium is at the margin of the deep lesion or has migrated over the edge and down the walls of the lesion.

Flaps are difficult to create from the inferior/nasal bulbar conjunctiva because the conjunctiva reflects on to the third eyelid a very short distance from the limbus. Fornix-based flaps advanced from the inferior nasal area tend to cause partial prolapse of the third eyelid (resulting in excessive tension on the graft) because the attachment of the bulbar conjunctiva is close to the third eyelid. A pedicle flap works well in this area.

When deciding where to begin a flap, consider using the conjunctiva closest to the lesion, but also consider what will happen to the visual axis. One should minimize the amount of conjunctival tissue that must be dissected free but prevent obstruction of the visual axis.
Fornix based (Hood or Advancement)

These are also known as sliding or hood flaps that utilize the bulbar conjunctiva. Because the bulbar conjunctiva is firmly attached to the limbus and since Tenon's capsule inserts at the limbus; it is difficult begin and continue a thin flap if the first incision is made at the limbus. In addition a thicker flap has more connective tissue attached and is more likely to contract and pull away from the sutures and result in a dehiscence.

To begin the procedure, tent up a small piece of bulbar conjunctiva adjacent to the corneal lesion and about 2-mm from the limbus. Next, make a 3 - 5 mm nick just through the conjunctiva with the tenotomy scissors pointed away from the cornea. Ideally, the tenotomy scissors should be slightly curved so the tips can be directed upward. Be careful not to perforate the conjunctiva and try to keep the flap thin enough so the tips of the scissors can be seen through the conjunctival tissue.

Advance the closed scissors tip into the wound with the tips up and then spread the blades. Work in an arc. It is usually necessary to extend the perilimbal incision at this point in order to advance the flap the necessary distance onto the cornea. Minimize tissue handling, which not only reduces the time it takes to do the procedure but also reduces the trauma the instruments inflict on the tissue, which could result in an unusable flap. Try to make every movement of your instruments accomplish a meaningful task. Once the flap has been developed and covers the lesion without tension, carefully debride a 1 - 2 mm margin of epithelium and anterior stroma from the perilesional area of the cornea to increase the chances of the flap adhering to the cornea.
Pedicle flaps
These are the next most common conjunctival flap and are also fashioned from bulbar conjunctiva. Before cutting the conjunctiva, visualize the pattern. The flap should rotate out onto the lesion with the shortest radius possible. It should also radiate onto the cornea from the direction that least obstructs the animal’s vision and not horizontally placed to avoid the eyelid margins from catching on the margin of the graft. The movement of the eyelids over the surface of the graft will not affect a pedicle that radiates out from the limbus either perpendicular to the eyelid margins or on angle. Try to create a flap with a length no more than three times its width in order to maintain the viability of the flap.
A tarsoconjunctival flap is a modification of the pedicle flap that is constructed from palpebral conjunctiva. This conjunctival pedicle configuration can be used when bulbar tissue is not available. It is not preferred, however, because the base of the flap remains attached to the eyelid, which can put undue tension on the suture line and result in dehiscence.
Bridge Flap

Bridge flaps
This is a variation of the pedicle flap except that it is continuous from limbus to limbus. This flap is more visually obstructive, less cosmetic, and involves more dissection and trauma to the globe. It is however more likely to remain viable because the blood supply enters from both ends of the flap. Dehiscence is also less likely because of the union with the bulbar conjunctiva at both ends. The main problems with this type of graft are its horizontal position and limitation on the width of the graft.
Island Grafts

Island grafts
With tarsal conjunctival and bulbar conjunctival island grafts, a button of conjunctiva is used to patch a thin and weak corneal area. The graft does not bring in an active blood supply. The tissue can be obtained from either the bulbar conjunctiva or the palpebral tarsal conjunctiva. The tarsal conjunctiva provides a thicker piece of tissue than the bulbar conjunctiva, and also provides greater support. This graft is indicated in non-infected descemetoceles where one is trying to avoid obstruction of cornea and a second surgery for graft trimming (as would be necessary with a pedicle. This graft is especially effective if there is a perilesional corneal blood supply that is already present.
The 360-degree flap
This flap completely covers the cornea in cases of extensive, malacic, and deep lesions. It is the most traumatic conjunctival flap because it requires a large amount of dissection. It also has a higher rate of dehiscence, especially when a purse-string suture pattern is used and the flap and cornea are not sutured together. I prefer to use the combination horizontal mattress and simple continuous pattern for this flap, which provides a more secure closure.
Corneal Scleral Conjunctival Transposition

The corneal scleral conjunctival transposition is an autograft of adjacent corneal/scleral/conjunctival tissue for the purpose of providing permanent structural support to a deep stromal corneal ulcer or Descemetocle; or a perforated corneal lesion. This procedure can be especially useful to attempt to maintain axial clarity when the lesion is centrally located. Even if this is not the case, this procedure provides a very strong graft as opposed to the thin layer of a conjunctival graft, especially if the cornea is perforated.

Two divergent incisions are made, extending from beyond the central extent in a divergent pattern toward the limbus. Next, two incisions are made perpendicular to the first two; when done, form a box around the deep corneal lesion. Next the corneal tissue between the proximal edge of the box and the limbus is dissected in a lamellar fashion, mid-stromal depth, to the limbus using a Sharptome or 64 Beaver blade. The dissection is continued at the same depth through the limbus so about 1 to 2 mm of limbus/sclera are undermined (more if necessary for a stronger graft over a large defect). Considerable bleeding normally occurs at this point due to the anterior ciliary vessels. A Bonn forceps should be used to handle the leading edge of the graft to avoid
maceration of the edge. An incision is then made through the sclera but not the conjunctiva from the underside of the graft toward the conjunctiva. This is the most difficult part of the surgery. One must be careful not to perforate the conjunctiva and only the sclera. Once the sclera is free the conjunctiva can be undermined to allow the entire graft to advance. There should be no tension on the graft when it is covering the lesion.

One 8-0 Vicryl suture is then pre-placed full thickness at each corner of the distal end of the graft. The graft is then allowed to rest in place and kept moist while the remainder of the surgery is completed. In case the cornea starts to leak during the last steps of the dissections the graft can be quickly brought into place and sutured in an attempt to seal the leak.

The last dissection step involves removing the corneal tissue from within the "box" inscribed around the descemetocele, to the same depth as the lamellar graft; 30 to 50% depth.
Lastly the graft is sutured into place. First the two pre-placed sutures are advanced to each distal corner and secured. Next either interrupted mattress sutures or simple interrupted sutures are placed.
General Graft Suturing Techniques

All grafts, except the 360° should be sutured to the cornea. Using a magnifying lens, corneal sutures should be carefully placed deep into the stroma, without full-thickness penetration. A 7-0 or 8-0 ophthalmic absorbable (Vicryl®) suture material works well. Vicryl® will remain in place for about four to five weeks. The suture retention time is quite variable, and is related not only to the type of suture material used, but also to the degree of corneal inflammation and the types of medication used. Steroids prolong suture retention; inflammation reduces the duration. It is usually best to let absorbable sutures fall out on their own. In most cases they should be removed only if a secondary problem develops such as a stitch abscess, untying, and occasionally when they are retained for too long and excessive inflammation, vesicles, bullae, or granulation tissue begin developing around them. If the sutures need to be removed, the procedure can be done with sedation and topical anesthesia in many patients; however, do not take chances and in the frisky patient, general anesthesia may be necessary to avoid trauma to the cornea.

Placement of the sutures requires magnification. During passage of the suture needle, the globe must be stabilized. This can be done using two episcleral perilimbal bulbar stay sutures of 6-0 or 7-0 silk placed 180 degrees apart. Or you can hold the globe steady with a fixation forceps 45° rat-toothed forceps with 1 x 2 (0.2 to 0.5 mm teeth), grasping the deep bulbar episcleral tissue adjacent to the area where the suture will be passed. Do not grasp with the fixation forceps on the conjunctival tissue to be used for the flap, because this will create holes in the tissue. The cut edge of the conjunctiva tends to roll in on itself, so it can be difficult to identify until it is carefully rolled out using a fine forceps. If the cut edge is not rolled out before suturing the flap to the cornea, the epithelial surface will face the ulcer bed and result in poor adhesion and inadequate coverage of the lesion.

The three basic patterns used to suture conjunctival flaps to the cornea are the simple continuous, simple interrupted and horizontal mattress patterns. Use a surgeon's knot and try to place the knot so it is on the conjunctiva. Deep erosions may develop around suture knots or tags that project from the knots onto the cornea. Usually, though, enough vascularization and granulation tissue builds up around the knots so that ulcerations are uncommon. At least five throws of the suture material are necessary to tie secure knots.

Combinations of the three basic suture patterns also can be used. The horizontal mattress and simple continuous patterns are a reliable combination. In deep lesions (descemetoceles), this combination of suture pattern results in an excellent seal. Make sure the sutures are not too tight, otherwise they will cut through the corneal or conjunctival tissue and dehiscence will occur.

After the flap is sutured to the cornea, the bulbar conjunctival wound where the flap was harvested should be sutured but it is not essential, especially if the bulbar conjunctival wound is large. Large wounds that are closed will obliterate the fornix and a lagophthalmos may develop. In these cases, allowing the bulbar conjunctival wound to heal by secondary intent is the best option. Tarsocconjunctival wounds are never sutured since they heal rapidly and suture placed in this area may result in erosion from it rubbing on the cornea.

Aftercare can be simple or complex depending on the seriousness of the condition (active infection or not) and the presence of other ocular problems (uveitis, KCS, etc). A topical broad-spectrum antibacterial ophthalmic ointment should be applied three to four times daily for the first 10 to 14 days after surgery. After 10 to 14 days, the flap should be well adhered to the cornea.
A topical antibiotic-steroid ophthalmic medication may be able to be used at about 14 - 21 days in those eyes that do not stain with fluorescein dye (it is OK if the suture knots stain positive) and that were not associated with a bacterial or fungal keratitis preoperatively. Because free grafts may require more time to heal, more time will be necessary before a topical steroid can be used. The corticosteroid will help reduce scarring, flap opacification, and reaction to the remaining sutures. Prudent use of the steroid should continue until all of the sutures are out and until the cornea is no longer inflamed.

If anterior uveitis is present postoperatively, a topical 1% atropine ophthalmic ointment must be used to produce mydriasis and cycloplegia. Concurrent topical nonsteroidal anti-inflammatory drug (NSAIDS) therapy will result in more effective mydriasis and pain relief, which should reduce the amount of atropine needed. Topical NSAIDS will decrease neovascularization and therefore may inhibit the initial adherence of the graft similar to a steroid.

If the conjunctival flap covers a significant amount of normal cornea in addition to the corneal lesion, the nonadherent parts of the flap that were not associated with the deep ulcer and were over normal cornea, could be trimmed off at about six to eight weeks postoperatively. Do not attempt to remove the conjunctiva that is covering the deep corneal defect. This area of conjunctiva must stay, since it is providing structural support.
Definitions

**Autograft:**
- Refers to "self" tissue transferred from one body site to another in the same animal.

**Isograft:**
- Grafts between genetically identical animals.

**Allografts:**
- Grafts between genetically different members of the same species.

**Xenografts**
- Grafts between different species.

**Inlay Lamellar Keratoplasty**

*Autogenous Inlay lamellar corneal grafts* (Corneal Scleral Conjunctival Transposition)
This is an excellent choice for a deep stromal axial lesion or Descemetocele. A lamellar section of adjacent clear cornea is transposed into the zone of the lesion after an appropriate bed has been made. The potential for a central clear visual axis is possible with this procedure.

**Xenografts:** *Inlay Lamellar Keratoplasty*

**Tectonic corneal graft** (frozen corneal tissue)

**Penetrating Keratoplasty** allografts or heterografts
Instruments, Suture and Materials

Magnification

Loupes

Operating Microscope

Instruments

- Wire Lid Speculum

- Bishop Harmon forceps
- Colibri forceps

- Bonn forceps

- Tying forceps

- Vanas Scissors

- Wescott Scissors

- Stevens Tenotomy Scissors
- **Sharptome® Blades**

- **Sharpoint®**

- **Sharptome® Microsurgical Knife**

One Unit STERILE Disposable

Sterility is guaranteed unless package is opened or damaged

- **Keratomes**

- **Castroviejo caliper**

- **Non-locking needle holder**
  i.e.: Barraquer Curved

- **Castroviejo Suturing Forceps (0.5 mm teeth) for globe fixation**

### Suture

- 7-0 VICRYL (polyglactin 910) suture (Ethicon J-566 with TG140-8 plus Spatula needle)
- 8-0 VICRYL (polyglactin 910) suture (Ethicon J-548 with TG140-8 plus Spatula needle)
- 9-0 VICRYL (polyglactin 910) suture (Ethicon V-549 with TG140-8 plus Spatula needle)
- 10-0 VICRYL (polyglactin 910) suture (Ethicon V-450 with TG140-8 plus Spatula needle)
- 6-0 and 7-0 SILK (Ethicon 7-0 Silk 7733 with TG140-8 plus Spatula needle) for stay sutures
- 4-0 MONOFILAMENT NYLON (Ethicon 1811-31 [DM21] with PRE-4 reverse cutting needle) for skin closure

Temporary tarsorrhaphy post-operatively

5-0 polypropylene PROLENE (Ethicon 8618 with PC-1 Conventional cutting needle) for skin closure (i.e.: lateral canthotomy skin).
Materials
- Cellulose sponges - spears  
  *Lint Free Sponges*
- 1/4" Penrose drain  
  *Small Pieces for Tarsorrhaphy Rubber Bumpers*
- Viscoelastic  
  *For reformation of the anterior chamber and manipulation of iris in the event of a corneal rupture*