Surgical Instrumentation and Techniques for Ophthalmology

What can you do in your practice?

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The Chapter gratefully acknowledges Vet Strategy as the sponsor of this session
Introduction

What makes ophthalmic surgery unique?

Preparation, instrumentation, principals of surgery, and post-operative care

Intraocular surgery – investment in equipment, performed regularly

Extraocular surgery - the most delicate surgery performed by the general practitioner
- modest investment in equipment
- frequent opportunity for extraocular procedures
- some specialized techniques
- requires strong knowledge of ophthalmic anatomy, physiology, diseases, and pharmacology

This lecture will not teach you how to do the procedures, but will give you the foundations needed to carry out the surgeries you learn from books, videos, future wet-labs.
Outline

1. Patient Selection and Preparation
2. Surgeon Preparation and Positioning
3. Anaesthesia and the oculocardiac reflex
4. Illumination and Magnification
5. Instruments
6. Needles and Suture
7. Procedures you can do and special considerations
8. Aftercare
1. Patient Selection and Preparation

a) Patient Selection:  Your patient selects you

Mitigate potential problems

i. Behaviour  - pre-surgery  - patient health – eye surgery is almost always elective
- trazadone to get to the clinic
- pre-med patient before placing catheter

- post surgery  - basket muzzle with ET tube (and tie) through it for easier removal
- E-collar on as soon as safe to do so
- pain control – tiny sutures, delicate work

ii. Antibiotics  - do not do surgery on an infected eye
- anticipate where the clot (filled with antibiotic) will be
- pre-operative antibiotics  - adnexal surgery – not needed unless infected
- orbital surgery – IV at time of surgery
- emergency surgery – IV at the time of surgery

iii Anti-inflammatory  - adnexal surgery – start a few hours before to decrease edema/pain
- orbital surgery – start a few hours before surgery or immediately after surgery (edema/pain)
b) Patient Preparation

Clip:
- apply gel to the eye
- small sharp shavers around the eye – abrasions are itchy
- eyelashes – trim with scissors

Scrub:
- 1:50, 0.2% povidone-iodine SOLUTION (not scrub)
  - crop feeder to access under the third eyelid and conjunctival fornices

Positioning:
- most adnexal/orbital procedures – sternal or lateral recumbency
  - head supported with towels/conformers
  - globe rotation
  - haemostats to grasp
  - fixation sutures
  - paralysis – typically for intraocular / corneal surgery

Draping:
- 3-4 Huck towels fastened with small towel clamps
  - fenestrated drape – 3 cm hole ideally round.

Post-op:
- no hydrogen peroxide
  - NaCl to remove blood from hair without staining (isotonic)
2. Surgeon Preparation and Positioning

- know your surgery
- be prepared for the worst and have a plan to deal with it
- eat before surgery
- pee before surgery
- seated with arms supported and table at appropriate height
3. Anaesthesia and the Oculocardiac Reflex

**General anaesthesia** - required for almost everything
- protocols – same as for regular surgery
- pre-surgical testing – same as for regular surgery
- quiet induction and smooth recovery – very important
- ocular lubrication essential
- the globe will naturally retract (enophthalmic) and rotate ventrally
- changes lid position, elevates TE, corneal exposure
- intraocular / some corneal procedures require paralysis with NM blocker
- post-op sedatives and/or pain control on hand in case of rough recovery

**Oculocardiac reflex** - not a common problem
- globe traction or pressure may result in decreased heart rate
- reduced likelihood with deep plane of anaesthesia or pre-med administration of an anti-cholinergic (glycopyrrolate/atropine)
- if occurs – stop ocular manipulations until it resolves or atropine if persists

**Patient monitoring** - difficult when head is draped – palpebral reflexes, jaw tone
- pulse oximetry, capnography, and doppler blood pressure to monitor (turn it up)
The Oculocardiac reflex / Ashner Reflex

Afferent:
Compression of globe → stretch receptors of EOM’s → long and short ciliary nerves → merge with Vo → nucleus of V (sensory) and X (motor)

Efferent:
Vagal nerve fibers → ↓ output of sinoatrial node → ↑ PS’c tone and ↓ HR
The Oculocardiac reflex / Ashner Reflex

-caused by globe traction or pressure

-results in decreased heart rate

-minimized by:
  -deep plane of anaesthesia
  -pre-med with anti-cholinergic (glycopyrrolate/atropine)

-treatment
  - stop ocular manipulations until resolves
  -treat with atropine or glycopyrrolate if persists
4. Illumination and Magnification

- both essential for surgery on or around the eye

**Illumination:**
- adnexal surgery standard operating lights
- focal / head-mounted light source

**Magnification**
- magnification required if procedure involves cilia, puncta, or cornea
- intraocular procedures - microscope

- 1.75-2.75 x
- 2-6 x
- 2.5 x
- 10 x, 1:6 zoom
5. Instruments
- vary tremendously in size and cost
- cost is highly correlated with quality

Care of your instruments
- handle with care
- pack individually (peel paks) with fenestrated tubular sleeves if needed or in a microsurgical tray
- washed in distilled water, ultrasonic cleaner, and follow with instrument milk
- fine brush – baby’s toothbrush - hinges

Haemostasis
- hemorrhage is usually minor
  - CTA’s or gauze squares – use caution not to touch the cornea
  - weck cell (cellulose) spears if corneal
  - direct pressure is generally all that is needed
  - irrigation with 1:10,000 epinephrine
A basic eye pack should include:

- Barraquer eyelid speculum
- Jaeger eyelid plate
- Fine-toothed Bishop-Harmon forceps
- Small Derf needle holders
- Curved Steven’s tenotomy scissors
Eyelid Speculum

Jaeger Lid Plate
Forceps

Bishop Harmon's

Manhattans

Colibri
Needle Holders

**Derf Needle Holders**
- needle size of 16 mm+ (≥ 4/0 suture) size
- built in scissors not recommended

**Castroviejo Needle Holders**
- needle size of ≤13 mm (≤ 5/0 suture) size
- do not use locking with corneal suturing
Stevens Tenotomy Scissors
- preparing conjunctival grafts
- Cherry eye surgery

Enucleation Scissors

Strabismus Scissors
- straight/curved for entropion surgery
Other useful instruments

**Cannulas** - 19-28 gauge
- for nasolacrimal flush

**Chalazion clamp** - for haemostasis and stabilization during eyelid surgery

**Blades** - #15 for almost all extraocular procedures

**Calipers** - to ensure symmetric entropion surgery
Needles and Suture

**Needles**

### Size and Curvature
- 3/8 circular
- 6.4 – 13 mm for absorbable suture
- 16 mm for non absorbable

### Needle codes
- P = plastics
- PS = plastic surgery
- PC = precision cosmetic
- FS = for skin

### Needle type and point
- Eyelid
- Cornea
- Skin

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**Packaging**

- Metric Gauge
- Imperial Gauge
- Needle code
- Needle size & curvature
- Needle type
- Needle point
- Needle profile
- Sterilised Ethylene Oxide
- Do Not Re-use
- See Instructions for use
## Suture

General rules apply – the strength of the suture should approximate the surrounding tissues

<table>
<thead>
<tr>
<th>Suture Type</th>
<th>Size</th>
<th>Absorbable</th>
<th>Non-absorbable</th>
<th>Monofilament</th>
<th>Multifilament</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicryl</td>
<td>4/0 – 9/0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PDS*</td>
<td>5/0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Monocryl</td>
<td>3/0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Nylon</td>
<td>3/0 – 5/0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Prolene</td>
<td>4/0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Silk</td>
<td>4/0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Skin, Eyelid, Conjunctiva, Cornea
Skin, Eyelid
Orbit (enucleation)
Skin, Eyelid*
Skin, Eyelid*
Eyelid*

* Absorbable if patient it difficult
Suture Patterns

**Temporary tarsorrhaphy (TT)**

- very useful eyelid suture
- provide temporary coverage for the cornea
- sedation or quick IV anaesthesia (eyelids are painful)
- half-thickness bite through eyelid - avoid full-thickness
  - aim for the meibomian gland openings

- 3/0-4/0 suture
- simple interrupted / horizontal mattress
- ± stents
Suture Patterns

Figure 8

- Mechanical barrier
- Secrete lipid portion of tear film
- Sweep away foreign bodies
- Spread tear film and directs it to puncta
Suture Patterns

Eyelid Tacking

- vertical mattress
- monofilament
- start 2-3 mm from eyelid margin
7. Special Considerations for the Procedures You Can Do

Eyelids
Enucleation
Third eyelid gland prolapse (Cherry eye)
Tear duct flush
Third eyelid flap

What instruments for each
What suture for each
Special tips/tricks
Not uncommon complications
7. Procedures You Can Do and Special Considerations

**Eyelid Surgeries:**

- tacking sutures
- entropion
- wedge resection

- extremely vascular
  - hemorrhage – profuse, nuisance
- allow for unconventional suture choices
- no cautery – scarring and conformational changes
- pain
7. Procedures You Can Do and Special Considerations

Eyelid Surgeries:

- **Tacking sutures**

**Instruments:** Bishop Harmon forceps, Derf needle drivers

**Suture:** - 4/0 nonabsorbable monofilament or 4/0 silk

**Tips/tricks:** - start 2-3 mm from eyelid margin

**Potential complications:** - sutures will start to reject in 2-3 weeks,
  - replace as needed or removal all if lid rolling in
7. Procedures You Can Do and Special Considerations

Eyelid Surgeries:

- Entropion

**Instruments:**  Bishop Harmon forceps  
Derf needle drivers  
sharp Tenotomy scissors

**Suture:** - 4/0 - 5/0 absorbable mono/multifilament

**Tips/tricks:** - ensure knots are as far away from the eyelid as possible

**Potential complications:** - not enough tissue removed – continued entropion  
-dog rubs sutures out
7. Procedures You Can Do and Special Considerations

Eyelid Surgeries:

- **Wedge Resection**

**Instruments:**
- Bishop Harmon forceps,
- Derf needle drivers
- straight hemostats

**Suture:**
- 4/0-5/0 absorbable mono/multifilament

**Tips/tricks:**
- clamp a v-shape on each side of the mass to reduce hemorrhage when cutting
- I rarely ever close the conjunctiva - buried knots resurface
- all knots on the skin side

**Potential complications:**
- 30% rule
7. Procedures You Can Do and Special Considerations

Enucleation:

**Instruments:**
- Bishop Harmon forceps
- Derf needle drivers
- Curved enucleation scissors
- Eyelid speculum

**Suture:**
- 4/0 vicryl – orbital rim, deep dermis, skin
- 6/0 vicryl - subcuticular

**Tips/tricks:**
- always remove the TE completely by piercing the base of the third eyelid and excising off the palpebral conjunctiva
- always remove the small nubbin of tissue at the medial canthus
- do not clamp or try to ligate vessels behind the globe
- remove lids last
- pre-surgical IV cefazolin
- bupivacaine splash block (1 ml large dog, ½ ml small dog)

**Potential complications:**
- count your gauze
7. Procedures You Can Do and Special Considerations

Third Eyelid Gland prolapse (Cherry Eye):

**Instruments:** Bishop Harmon forceps, Derf needle drivers, Eyelid speculum, Sharp Tenotomy scissors, 2 hemostats

**Suture:** - 5/0 PDS or 6/0 vicryl

**Tips/tricks:** - use the two hemostats attached to each side of the TE leading edge to roll the TE over to expose the gland
- place all knots on the palpebral (lid) side of the TE
- place 2-3 full-thickness SI sutures between the two original knots of the SC line
- BNPH following surgery if no ulcer

**Potential complications:** - reprolapsed
- giant breeds, Great Danes, bulldogs, Cocker Spaniels
Exposed third eyelid gland (cherry)

Cut suture short

All knots on the eyelid side of the third eyelid

Full-thickness sutures
7. Procedures You Can Do and Special Considerations

**Nasolacrimal Flush:**

**Instruments:**
- NL cannula / 24 ga catheter
- 3 ml syringe
- lots of tissues
- topical anesthetic (Alcaine-Proparacaine)

**Suture:**

**Tips/tricks:**
- fill the 3 ml syringe with saline and fluorescein
- infuse into whichever punctum you find
- block to the fellow punctum to create drainage path to nostril
- If not ulcer - if duct was blocked and flushed patent, infuse Maxidex into the duct to resolve indwelling cell buildup. Home with topical anti-inflammatory.

**Potential complications:**
7. Procedures You Can Do and Special Considerations

**Third eyelid flap:**

**Instruments:**  
Bishop Harmon forceps,  
Derf needle drivers  
Eyelid speculum  
Stent

**Suture:**  
- 4/0-5/0 non-absorbable monofilament (Nylon)

**Tips/tricks:**  
- start by piercing the stent before going through the upper lid  
- ensure that your TE suture is under the cartilage but not full-thickness  
- leave sutures ends long if you need to lower the TE to check the cornea so they can be re-tied.  
- ensure that when the TE is raised, that no cornea is exposed

**Potential complications:**  
- cornea not completely covered by TE and suture rubs on cornea
8. Aftercare

E-collar - hard only
- extends past end of nose
- from time of surgery to when sutures are removed/wounds healed
- check underneath the collar 1-2 times daily for skin irritation

Optivizor

Keep surgery site clean – warm wet compresses to soften debris

Topical broad-spectrum antibiotic + corticosteroid if marked swelling

Pain control
References

Ocular surgery

General
1. Stanley RG. Suggested Eye Surgery Instruments. [Not Published.]
5. Stades FC, Boeve MH and van der Woerdt A. Palpebral fissure length in the dog and cat. Prog In Veterinary and Comparative Ophthalmology; 2(4):155-161.
Never be afraid to try something new. Remember, amateurs built the ark, professionals built the Titanic.
Thank you!

The Chapter gratefully acknowledges Vet Strategy as the sponsor of this session
### Anesthetic Considerations in the Ophthalmic Patient

**Preoperative Considerations**
- **Associated conditions**
  - May be geriatric with comorbidities
- **Blood work**
  - HCT
  - TP
  - In patients older than 5-7 yr, consider CBC, electrolytes, BUN, and Cr
  - Consider cardiac work-up if heart murmur is present
- **Physical examination**
  - May be painful at presentation depending on the cause
- **Premedications**
  - If patient is anxious, give the following:
    - Diazepam (0.1-0.2 mg/kg IV), or
    - Midazolam (0.1-0.2 mg/kg IV, IM), plus
    - Hydromorphone* (0.1-0.2 mg/kg IV, IM in dogs; 0.05-0.1 mg/kg IV, IM in cats), or
    - Morphine [0.1-0.2 mg/kg IV or 0.2-0.4 mg/kg IM], or
    - Buprenorphine* (0.005-0.02 mg/kg IV, IM) if only moderate pain is anticipated

**Intraoperative Considerations**
- **Induction**
  - If premedicated, give:
    - Propofol (2-4 mg/kg IV), or
  - If no premeds given, then:
    - Propofol (4-8 mg/kg IV)
  - Do not use a face mask if the animal has increased IOP
- **Maintenance**
  - See Box 17.1 for neuromuscular blockers and reversal agents
  - Isoflurane or sevoflurane, plus
    - Fentanyl (2-10 μg/kg IV PRN in dogs; 1-4 μg/kg IV PRN in cats) for short-term pain relief, plus
    - Hydromorphone* (0.1-0.2 mg/kg IV PRN in dogs; 0.05-0.1 mg/kg IV in cats PRN), or
    - Morphine [0.1-0.5 mg/kg IV PRN in dogs; 0.05-0.2 mg/kg IV PRN in cats], or
    - Buprenorphine* (0.005-0.02 mg/kg IV PRN), plus PRN
  - If severe bradycardia or other dysrhythmias, give atropine (0.02-0.04 mg/kg IV) or
glycopyrrolate (0.005-0.01 mg/kg IV)
  - Avoid nitrous oxide if a gas bubble is injected into globe.
- **Fluid needs**
  - 5-10 ml/kg/hr
- **Monitoring**
  - Blood pressure
  - HR
  - Respiratory rate
  - ECG
  - ETCO2
  - SpO2
  - Temperature
  - Nerve stimulator if neuromuscular blockers are used
- **Blocks**
  - Retrobulbar block—0.5% bupivacaine 2 ml for dogs up to 15 kg and 3 ml for dogs > 15 kg (max of 2 mg/kg) or 2 ml of 1% lidocaine (see p 292)
  - Topical analgesia such as proparacaine, lidocaine, or carbocaine

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From: Fossum T Small Animal Surgery Ch 17 Surgery of the Eye. 2013
<table>
<thead>
<tr>
<th>Postoperative Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analgesia</strong></td>
</tr>
<tr>
<td>- Morphine (0.1-0.5 mg/kg IV or 0.1-2 mg/kg IM q1-4hr in dogs; 0.05-0.2 mg/kg IV or 0.1-0.5 mg/kg IM q1-4hr in cats), or</td>
</tr>
<tr>
<td>- Hydromorphone* (0.1-0.2 mg/kg IV, IM q3-4hr in dogs; 0.05-0.1 mg/kg IV, IM q3-4hr in cats), or</td>
</tr>
<tr>
<td>- Buprenorphine† (0.005-0.02 mg/kg IV, IM q4-8hr or 0.01-0.02 mg/kg OTM q6-12hr in cats), plus</td>
</tr>
<tr>
<td>- Carprofen (2.2 mg/kg PO q12hr in dogs), or</td>
</tr>
<tr>
<td>- Deracoxib (3-4 mg/kg PO q24hr for &lt; 7 days in dogs), or</td>
</tr>
<tr>
<td>- Meloxicam‡ (0.1-0.2 mg/kg once SC or PO, then 0.1 mg/kg PO q24hr in dogs; 0.05-0.1 mg/kg PO, SC once in cats)</td>
</tr>
<tr>
<td><strong>Monitoring</strong></td>
</tr>
<tr>
<td>- SpO₂</td>
</tr>
<tr>
<td>- Blood pressure</td>
</tr>
<tr>
<td>- HR</td>
</tr>
<tr>
<td>- Respiratory rate</td>
</tr>
<tr>
<td>- Temperature</td>
</tr>
<tr>
<td><strong>Blood work</strong></td>
</tr>
<tr>
<td>- Usually not needed</td>
</tr>
<tr>
<td><strong>Estimated pain score</strong></td>
</tr>
<tr>
<td>Can be mild to moderate depending on cause and/or procedure</td>
</tr>
</tbody>
</table>
Slides not used
5. Instruments

CHAPTER 3 - OPHTHALMIC INSTRUMENTS AND SUTURES

OPHTHALMIC SURGICAL INSTRUMENTS

ADEQUATE SET FOR MOST OPHTHALMIC PROCEDURES WOULD BE:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Price range - 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Needle holder</td>
<td>$60-350</td>
</tr>
<tr>
<td>2. Corneal forceps</td>
<td>155-350</td>
</tr>
<tr>
<td>3. Fixation forceps</td>
<td>125-180</td>
</tr>
<tr>
<td>4. Cilia forceps</td>
<td>5-50</td>
</tr>
<tr>
<td>5. Arruga capsule forceps</td>
<td>80-125</td>
</tr>
<tr>
<td>6. Corneal scissors</td>
<td>90-130</td>
</tr>
<tr>
<td>7. Utility (iris) scissors</td>
<td>45-90</td>
</tr>
<tr>
<td>8. Cyclodialysis cannula</td>
<td>20</td>
</tr>
</tbody>
</table>

Comment. Good quality curved mosquito hemostatic forceps can be substituted for fixation forceps.
Example: \((2 \times) \text{ DLZ} - 6.2 - 150\)

<table>
<thead>
<tr>
<th>Circle Code</th>
<th>Needle Point</th>
<th>Needle Length in mm</th>
<th>Needle Diameter in (\mu) (micron)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V = 1/4</td>
<td>LZ = Spatula</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D = 3/8</td>
<td>RS = Taper Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H = 1/2</td>
<td>DS = Taper Cut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B = bicurved</td>
<td>DK = Reverse Cutting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G = straight</td>
<td>DSL = Soft Cutting point cardio</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of needle shapes](image)
<table>
<thead>
<tr>
<th>Non-absorbable</th>
<th>Characteristics</th>
<th>Frequent users</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYLON</td>
<td>Monofilament polyamide with high tensile strength. The uniform and smooth surface permits effortless passage through tissue with minimum trauma. Extremely well tolerated.</td>
<td>First choice material for ophthalmology and microsurgery.</td>
</tr>
<tr>
<td>POLYPROPYLENE</td>
<td>More pliable and soft, smooth passage through tissue. Excellent knot security, superior tensile strength.</td>
<td>Absolutely minimized trauma. Mostly used in cardiovascular surgery, as well as ophthalmology.</td>
</tr>
<tr>
<td>POLYESTER</td>
<td>Polyester with improved tensile strength and knot security. A modern braiding technique (braided Polyester) gives the strand a smooth and uniform surface that minimizes the trauma.</td>
<td>Plastic, hand surgery, ophthalmic and cardiovascular surgery.</td>
</tr>
<tr>
<td>VIRGIN SILK</td>
<td>Twisted strand (Virgin silk), very smooth and with high knot security. Braided surgical silk on twisted core for greater tensile strength.</td>
<td>Ophthalmic surgery.</td>
</tr>
</tbody>
</table>

**Absorbable**

| PGA                            | Predictable absorption, high tensile strength, excellent knot security, reliable bioabsorptability. | Wherever eventual absorption is required. |

**Absorbable**

| PGA                            | Predictable absorption, high tensile strength, excellent knot security, reliable bioabsorptability. | Wherever eventual absorption is required. |
Many specialized sutures and needles are available for ophthalmic surgery. The cornea and sclera are very dense and cannot be easily sutured unless proper ophthalmic needles (reverse cutting or spatula) are available (Table 3-1).

Absorbable suture may be used to eliminate the need for suture removal.

**CORNEAL SUTURE REACTION IN DECREASING SEVERITY**

Surgical gut and collagen - most severe reaction

Silk - for many years the most popular ophthalmic suture

Polyglactin 910 (Vicryl) and polyglycolic acid (Dexon) - If silk is removed from the cornea at two weeks, the reaction will be about the same as seen with Vicryl and Dexon when they come out at 3.5 weeks.

Polyglyconate (PDS or Maxon) - least reaction of absorbable suture

Nonabsorbable synthetic sutures - results in the least tissue reaction

**SILK** - can be used in all ocular tissues

Excellent for short term procedures (eyelid and globe stabilization during surgery, and third eyelid flap). Very easy to work with, has the softest exposed ends. Has been replaced in corneal surgery by synthetic sutures.

**COLLAGEN AND SURGICAL GUT** - can be used for buried suture in conjunctiva and eyelids. Not as easy to handle as silk. Synthetic absorbable sutures are preferred by most surgeons.

**SYNTHETIC ABSORBABLE SUTURES** - are used in all tissues, especially cornea. Can be used in the skin when nonabsorbable sutures would be difficult to remove. Suture ends are stiffer than silk and can cause irritation. Absorption occurs in two phases: loss of tensile strength during early postoperative period, followed by loss of mass when most of the tensile strength is gone.

Dexon and Vicryl - will remain in tissues about 3.5 weeks. Currently the most popular corneal suture is veterinary medicine.

Maxon and PDS - absorb more slowly and produce less tissue reaction

**SYNTHETIC NONABSORBABLE SUTURE**

Monofilament nylon (Dermalon, Ethilon) - excellent skin and corneal suture. It can be buried. Suture tips are soft, therefore suture should be trimmed closely to avoid irritation.

Flec sutures (8.0 and smaller) can be left in the cornea without causing irritation if suture tips are cut short or the knot buried. More difficult to work with and requires special knot.

Braided nylon (Norton, Sarga) - same indications as monofilament nylon but does not have soft ends.

Polypropylene (Protexen, Surglene) - same indications as nylon.

Polybutester (Novafil) - least reactive suture available and has same indications as nylon.