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Ocular Surgery for Advanced Practitioners Mini Series

Session Three: Surgery of the cornea and principles of intraocular surgery

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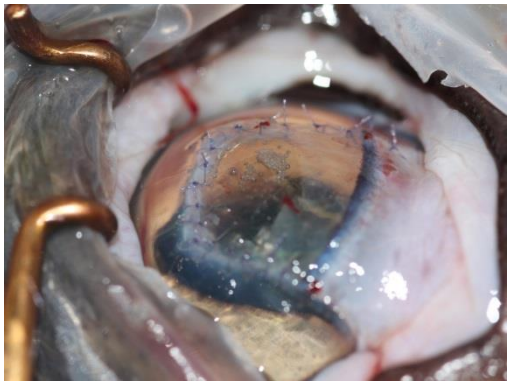

Session 3: Surgery of the cornea and principles of intraocular surgery

Corneal surgery

When operating the cornea it is important to consider its anatomical structure. The cornea is covered by the mitotically active epithelium which forms approximately 10 % of the corneal thickness and has a shield like function. The main body of the cornea is formed by the stroma (90%), which mainly consists of collagen fibres and few interspersed keratocytes. The stroma provides the mechanical strength to the cornea. The inner layer of the cornea is the single layered endothelium with its basement membrane, the Descemets membrane. The cornea of dogs and cats is about 0,5 – 0,6 mm thick.

Given the fine structure of the cornea, surgeries of the later have to be done under an operating microscope for adequate magnification. Microsurgical instruments allow good tissue handling with minimal trauma.

Mono- and polyfilament suture material may be used for corneal surgery, with the size starting at 8/0 going up to 10/0 for the experienced surgeon. A spatula shaped needle is best suitable for the use within the stromal collagen lamellae. While nylon is the least reactive suture material for the cornea, as non-resorbable material it may have to be removed as the sutures loosen with time.

Patients are easiest positioned with deflatable buster bags. The eye is best put in a horizontal and central position. The central position is best achieved with the use of neuromuscular blocking agents. Alternatively stay sutures may be placed at the limbus and artery forceps can be used to direct the globe into different positions as required during surgery.

To reduce tissue damage there should be only essential manipulation and the surgeon should aim to hold tissue that will be removed during the procedure, if possible. The globe may also be held at the limbus where conjunctiva and cornea are in close association.

A corneal suture should extend to 70 -90 % of the corneal depth. As deep as possible for good tissue alignment but not penetrating to avoid an aqueous humour leak.

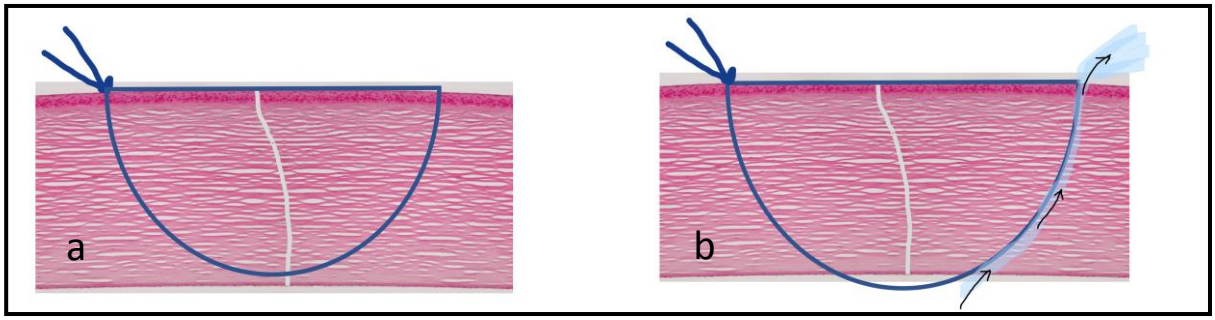

Figure 1: Correctly positioned corneal suture (a) and penetrating corneal suture (b) causing an aqueous humour leak.

Single sutures create compressions zones between the two wound margins. These should reach each other or may overlap slightly to assure adequate wound closure.

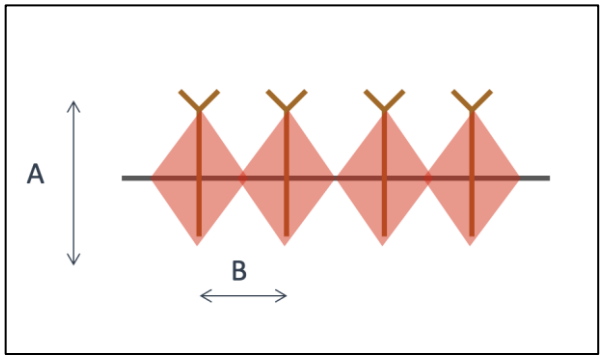

Figure 2: Compressions zones of single interrupted sutures.

Continuous sutures require more experience but result in a more even wound compression. Fewer knots usually means that patients are more comfortable. While the number of partial knots varies between surgeons, a 2 + 1 + 1 pattern seems the most common consent. Important is the placement of a square knot rather than a slip knot which is not stable, by carefully laying down the suture ends when knotting.

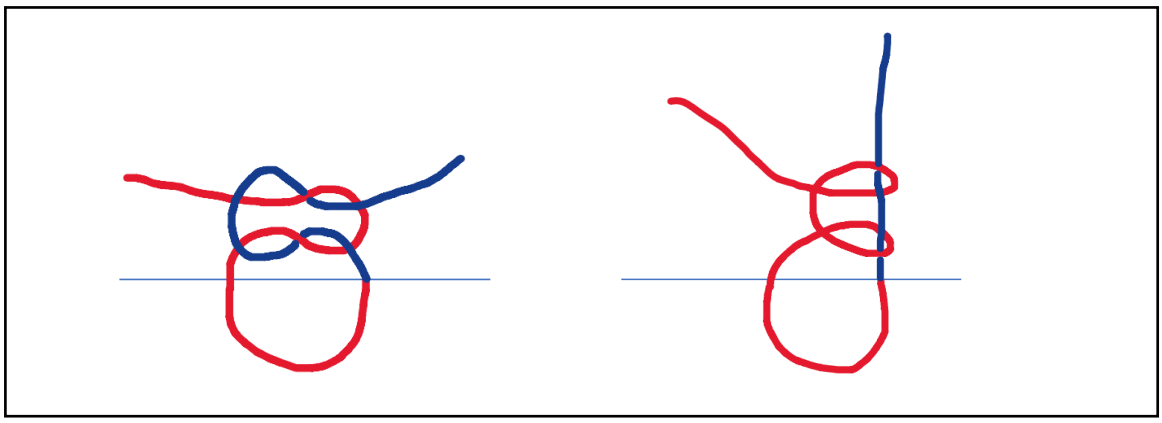

Figure 3: The correct square knot (left) compared to the insecure slip knot (right)

Corneal foreign bodies

Corneal foreign bodies in dogs are usually plant material like thorns and husks. They may just be stuck to the corneal surface or penetrate through the tissue and may even enter the eye. The examination of the cornea with a slit lamp allows to assess the depth of such lesions. In patients were a penetrating injury is suspected the pupil should always be dilated (often requires atropine eye drops, rather than the weaker tropicamide) to assess the lens capsule for any defects. While smaller defects may heal spontaneously, larger lesions require the removal of the lens material via phacoemulsification. Depending on the extent of the lesion an artificial intraocular lens may be placed to maintain normal vision.

Superficial foreign bodies may be removed under local anaesthesia using a cotton tip applicator or cytobrush. Deeper foreign bodies with a risk of perforating the eye or which are already perforating the cornea should be removed under the operating microscope. The surgeon should be prepared to manage an aqueous humour leak. Foreign bodies are best removed with two small needles which are used to grab the plant material and push it back towards the ocular surface. Foreign bodies need to be pushed out of the cornea, rather than trying to pull them out with forceps which is more likely to push the foreign body into the eye. If the foreign body is lost in the anterior chamber it has to be removed following the principles of intraocular surgery with a sperate access to the eye and ophthalmic viscoelastic devices to mobilize the plant material and allow removal.

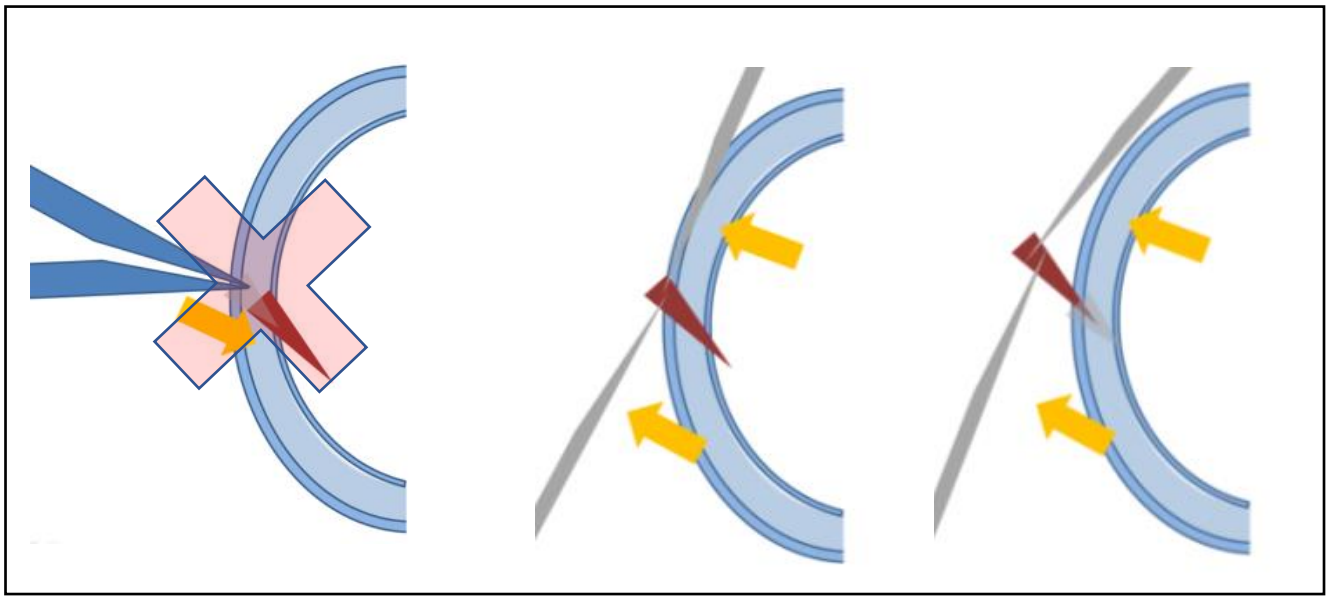

Figure 4: Corneal foreign bodies should be pushed out of the cornea with two small needles. Pulling the foreign body with forceps may result in pushing it deeper into the cornea or even into the eye

Corneal lacerations

Corneal lacerations occur due to sharp injuries to the cornea. They may create deep corneal defects, corneal flaps or penetrating wounds with or without damage to the intraocular structures.

Corneal flaps that often move at each blink prevent healing of the corneal wound. Shallow corneal flaps may be removed under local anaesthesia with or without sedation. Larger or deeper defects should be sutured. The decision as to whether or not a lesion should be sutured is made based on the temperament of the patient as well as the size and the shape of the wound. If the axis of reflection is placed outside of the laceration wound suturing is indicated. Conservative management may be an option, if the the axis of reflection is within the laceration.

Wound closure may be done by direct suturing or, if there is significant tissue loss by performing different grafting procedures. Intraocular haemorrhage may, depending on severity, be irrigated and aspirated from the anterior chamber through a separate perilimbal incision or be left to resorb on its own. Either way, the pupil should be dilated to minimize the risk of adhesions between iris and lens. A prolapse of iris should be replaced, unless the tissue is severely damaged, in which case a partial dissection would be indicated. The

replacement is done mechanically using an iris repositor and an ophthalmic viscoelastic device. The latter is easiest injected via a separate incision at the limbus. The iris is a very vascular tissue, any resection should be done using electrocautery to minimize bleeding. Eyes with penetrating lacerations should always be investigated for possible injuries to the lens capsule (see penetrating corneal foreign bodies).

Lamellar keratectomy

A lamellar keratectomy is used to excise diseased corneal stroma for the treatment of for example dermoids, corneal sequestra in cats, non-healing corneal ulcers and to debride the ulcer bed in corneal surgery. Under the operating microscope the diseased corneal is outlined with a restricted depth knife (different depths) and then dissected using a lamellar dissector or a crescent knife. The dissected cornea is excised with a pair of fine corneal scissors. Depending on the depth of the lesion, grafting procedures may be necessary to stabilize the cornea. To protect the healing eye a bandage contact lens and or temporary tarsorrhaphy may be considered.

Grafting procedures of the cornea

To stabiliize deep or penetrating corneal defects different grafting techniques are available, including a corneoconjunctival transposition, a corneal transplant, an A-cell graft or an amniotic onlay graft.

A corneoconjunctival transposition means that neighboring cornea is transposed into the defect, keeping the connection with the conjunctiva at the limbus. The transposed cornea has an excellent mechanical stability and a good potential to clear over time. Nonetheless, the attached conjunctiva allows for reasonably fast vascular supply.

A corneal graft means that heterologous or sometimes autologous cornea is moved into the defect to stabilize the cornea. The mechanical stability is excellent. Vascularisation of the graft occurs rather late and if possible, may be prevented for best corneal transparency after surgery.

For both procedures, the corneoconjunctival transposition and corneal transposition it is essential, that after graft preparation the ulcer bed is debrided. This means that any diseased tissue is removed. In case of a partial epithelialization of the defect, the epithelium

is removed to allow the transposed tissue to heal in well. This needs to be taken into consideration when planning the graft size.

An amnion onlay graft may be used for extensive melting corneal ulcers. The amniotic membrane may be sutured to the limbus in multiple layers. It provides mechanical stability, has collagenase-inhibiting qualities and is epitheliotrophic. Its temporary support allows natural healing and leaves a good chance for some transparency of the cornea in the future while most other grafting techniques in an extensive lesion may be blinding.

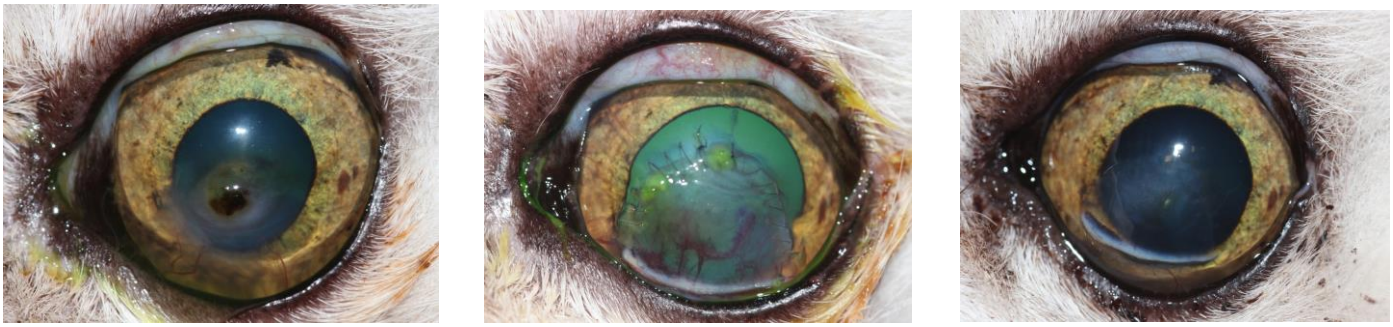

Figure 5: Corneal sequestrum in a cat which has been removed via a deep lamellar keratectomy. The created defect resulted in a fragile cornea which was stabilized with a corneoconjunctival transposition from ventral. Few weeks later the transposed cornea is almost perfectly transparent. The limbus which is connecting cornea and conjunctiva remains visible as a white line.

Intraocular surgery

Intraocular surgery should be reserved for the experienced ophthalmic surgeon. Surgical skills can be practices on cadaver eyes. Pigs' eyes from slaughterhouses, if available, provide a reasonably realistic model, apart from a significantly thicker cornea, due to post mortal corneal oedema.

Necessary equipment includes an operating microscope, adjustable operating table and operating chair with arm rests. The patient's head is easiest positioned with a deflatable buster bag. The eye should be roughly horizontal in position. A central position of the eye during anaesthesia is easiest maintained with neuromuscular blocking agents, which make

active ventilation of the patient essential. Alternatively, stay sutures may be used to control the position of the globe.

Specific intraocular instruments are required which are big enough to handle but small enough to allow good movement within the eye. Most knifes and blades to enter the eye are single use and even delicate instruments are available as single use. Reusable instruments are most commonly utilised but are demanding in terms of care as false handling may break tiny teeth or mal alight fine forceps, making them unusable.

Ophthalmic viscoelastic devices (OVDs) are used for intraocular surgery. These are transparent, gel-like substances with different qualities. They are used to create space in the anterior chamber, manipulate ocular structures (floating up pieces of lens material, keeping iris away from the wound etc.) or to coat structures like the corneal endothelium to protect the sensitive cells during surgery or to coat the artificial intraocular lens to ease its injection into the capsular bag with as little resistance as possible.

The most common intraocular surgeries are lens extractions in patients with a lens luxation and the removal of cataracts, followed by the placement of an artificial intraocular lens if possible.

A lens luxation is a condition were the zonules, which keep the lens in position, break resulting in a lens that is moving freely within the eye. Particularly the movement of the lens into the anterior chamber often results in an increased intraocular pressure which may cause damage to the retina and optic nerve. An anteriorly luxated lens may be removed from the eye either via an intracapsular lens extraction or via phacoemulsification.

Intracapsular lens extraction

In this surgery the lens is removed in one piece through a large corneal incision (approximately 180°). To get good access to the eye a lateral canthotomy if often necessary. Following the two-stepped corneal incision and removal of the lens via lens loop or better an ophthalmic viscoeleastic device, an automated vitrectomy is recommended to remove vitreous humour from the anterior chamber and to perform a core vitrectomy. This means that the central part of the vitreous is removed to reduce the risk of post-inflammatory traction bands which may lead to a retinal detachment after surgery. The corneal wound is closed in a continuous fashion, followed by closure of the lateral canthotomy wound.

Patients without lens are far sighted, but usually adapt within few days after surgery showing good functional vision at a distance. Near vision however remains limited.

A luxated lens may also be removed via phacoemulsification. For this technique two small corneal incisions are used to access the eye. An OVD is injected behind the lens to prevent it from falling back. The lens capsule is then opened, and the lens material is fragmented and aspirated from the eye. While one hand is holding the phacoemulsification hand piece, the other supports the lens and prevents then lens from dropping into the posterior segment. The removal of the lens is completed by pulling the lens capsule out of the eye. This is followed by a core vitrectomy and the removal of vitreous from the anterior chamber, if this hasn't been done already. Corneal wounds are closed routinely.
The removal of the lens via phacoemulsification may be less traumatic to the eye and prognosis for vision may be better long-term, however peer- reviewed studies on this topic have not yet been published.

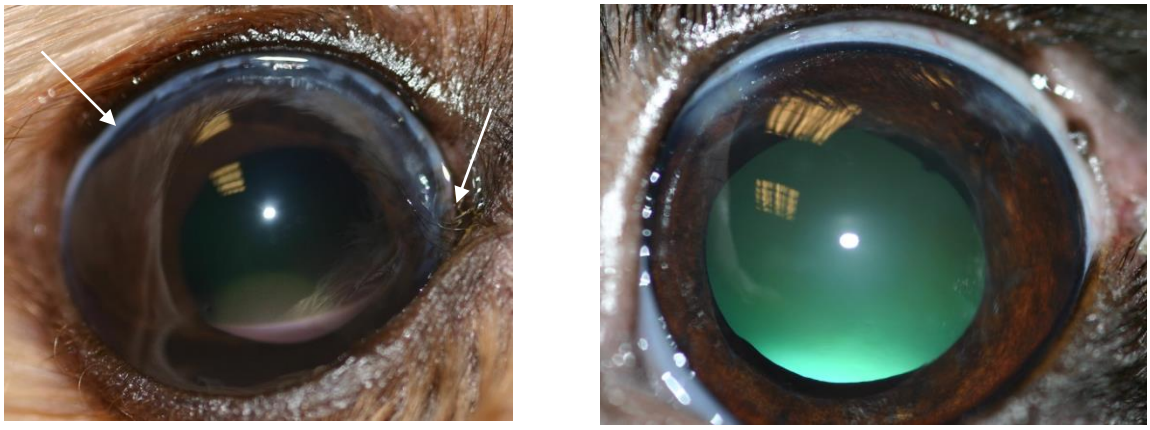

Figure 6: The right eye of a dog following an intracapsular lens extraction, note the wide scar along the dorsal limbus and the left eye of a dog following the lens extraction via phacoemulsification. Note the two small incisions at 11 and 2 o'clock.

Cataract surgery

Just as in humans, cataracts in dogs are removed via phacoemulsification. A lateral canthotomy may be necessary to access the eye. One or two perilimbal incisions are made, depending on requirements or surgeons' preference. The anterior chamber is stabilized with an OVD. The anterior lens capsule is opened via a continuous curvilinear capsulorrhexis.

It is essential that the capsulorrhexis is perfectly round, to prevent tearing of the anterior lens capsule during surgery, which may prevent the placement of an artificial intraocular lens. The cataractous lens material is then removed via phacoemulsification in a coaxial or bimanual fashion. The cortex of the lens is then aspirated. The eye is again stabilized with the help of an OVD and the artificial intraocular lens is injected into the capsular bag. The OVD is irrigated and aspirated from the eye and the corneal wounds are closed, followed by closure of the canthotomy wound.

The surgery becomes more complex in the presence of vitreous humour in the anterior chamber, in case of a ruptured lens capsule or other complicating factors. Cataract surgery should always be learned in the presence of an experienced surgeon that can help to deal with unexpected complications.

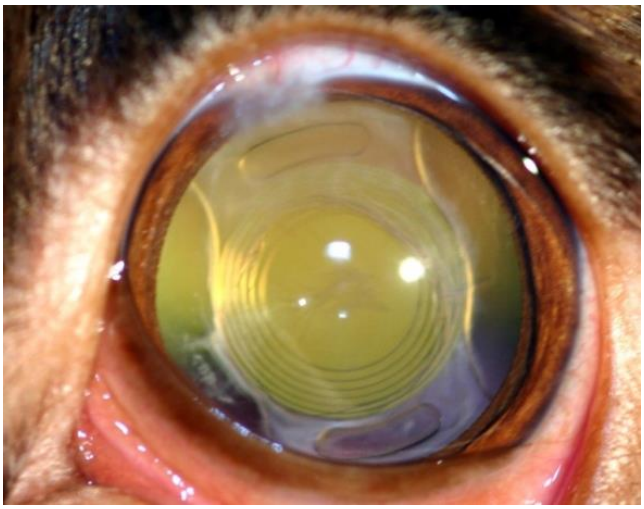

Figure 7: Eye following cataract surgery. The pupil has been dilated. Note the healing corneal wound at 12 o'clock and the artificial intraocular lens which is held in place by the haptics, the extensions of the lens that anchor it in the capsular bag.