

Enucleation in companion animals

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Enucleation is the surgical removal of the globe. It is most often carried out in blind, painful eyes which are unresponsive to treatment. In appropriate cases, enucleation offers a humane alternative to constant pain, the threat of neoplasia metastases, or euthanasia of an otherwise healthy animal. While it is a procedure which is well tolerated by pets, owners may find the issue very emotive and therefore have a resistance to the concept of enucleation. However, if the eye is blind and painful, there is no doubt that the animal will be very much happier without it. Many owners wish they had taken the advice sooner when they see the result in the animal's overall comfort and improved demeanour after the procedure.

Indications for enucleation

Indications for enucleation include the following:

- Raised intraocular pressure resulting in glaucoma (a very painful and blinding condition) which is unresponsive to treatment (Figure 1);
- Intraocular neoplasia with the potential to cause severe intraocular pain or to metastasise, which is not amenable to alternative medical or surgical treatments (Figure 2);
- Severe trauma resulting in a perforated eye or damage to the lens – often a result of a cat scratch, a dog bite or a road traffic accident (Figure 3);
- Intraocular infection / endophthalmitis;
- Phthisis bulbi – a small shrunken globe may cause no problems but if it is chronically inflamed or is causing secondary entropion, these globes should be removed;
- Proptosis where there is extensive severing of the extraocular muscles, significant damage to the globe itself or obvious avulsion of the optic nerve (Figure 4); and,
- Retrobulbar disease such as neoplasia, where the only access is through the orbit.



Figure 1: A 10-year-old Bassett hound with acute ocular pain, episcleral congestion, corneal oedema, fixed pupil and lack of visual responses due to acute glaucoma.



Figure 2: A smooth, dark mass is occupying most of the anterior chamber in the eye of this 12-year-old domestic short-haired cat with an intraocular sarcoma.



Figure 3: A painful, non-visual eye in a one-year-old domestic short-haired cat with scleral rupture due to a gun shot, with the entry wound visible above the eye.



Figure 4: A two-year-old Shih Tzu 20 minutes after traumatic proptosis of the left eye. The dog was 'scruffed' by another dog.

Preparation for surgery

There are a variety of enucleation techniques. The method chosen depends on specific factors relating to the eye, as well as the surgeon's preference and experience. The animal will need to be suitable for a general anaesthetic, although in an emergency situation, certain risks are acceptable.

There are certain anaesthetic considerations to take into account. Monitoring of the anaesthetic will be made more difficult for the anaesthetist because the face will be covered during surgery by the drape. The anaesthetist will not be able to use the palpebral reflex, assessment of globe position or jaw tone to assess the depth of anaesthesia. Remote monitoring (Figure 5) may be facilitated by the placement of an oesophageal stethoscope, a pulse oximeter (with the probe attached to the prepuce or vulva for easy



Figure 5: Remote monitoring of the patient is important as access to the head area will not be possible under drapes.

replacement), a capnograph, a rectal thermometer and a blood pressure monitor alongside palpation of the femoral pulse.

In preparing for surgery there are several important points to remember:

- It is recommended to mark the eye to be removed in front of the owner with Tippex (Figure 6) or a marker. This should help prevent a serious mistake.
- Essential equipment should be assembled (Table 1).
- The endotracheal tube tie should be secured around the lower jaw rather than around the head, in order that it stays as far away from the surgical site as possible (Figure 7).
- Eye ointment or gel should be placed on the corneal surface to minimise hair clippings entering the periorbital area, as these short hairs are difficult to remove afterwards (Figure 7).
- The area approximately 3cm around the eye is clipped, taking care not to traumatise the thin eyelid skin.
- The conjunctival sac, the globe and the periorbital area should be prepared for aseptic surgery using dilute povidone iodine solution at a concentration of 1:50. While in this case the eye will be enucleated, it is best practice to use non-detergent based iodine around the eye as the detergent can cause severe damage to the eye.
- The head is positioned optimally and this is facilitated by the use of a buster cushion (Figure 8).
- The surgeon may stand or be seated, depending on which position they find the most comfortable. Veterinary ophthalmologists tend to remain seated.

Surgical techniques

Choosing a technique for enucleation depends on the objectives to be achieved. Factors to take into account include the reason for enucleation and the cosmetic outcome desired. Owners may wish to discuss the benefits and disadvantages of various techniques before the operation, as discovering that an alternate technique could have been performed could lead to feelings of disappointment afterwards.



Figure 7: The endotracheal tube is secured around the lower jaw to keep it out of the way of surgery. Gel tears are placed on the eye before clipping to reduce the number of hairs that can fall into the



Figure 6: The left glaucomatous eye has been marked with Tippex pre-operatively to avoid any possible confusion.

Table 1: Equipment needed for enucleation in companion animals

* Sterile drapes
* Scissors: Steven's tenotomy scissors, curved Metzenbaum scissors or Mayo scissors
* Toothed forceps for grasping the conjunctiva
* Curved haemostats
* Needle holders with small tip for grasping finer needles
* Swabs
* Pot of formalin
<i>In addition, the trans-palpebral / exenteration techniques require:</i>
* Allis tissue forceps
* Scalpel handle
* Scalpel blade
* Implants:
Silicone prostheses, available in a variety of sizes 14-22mm for small animals
* Carter sphere introducer
* Spay hook, two artery forceps or evisceration scoop
* Suture material: Fine absorbable suture material with swaged-on needles contribute to a more atraumatic repair with good apposition and optimal healing.
The size of suture material used depends on the surgeon's preference, but it is usual to use 3/0 to 6/0 non-absorbable monofilament material



Figure 8: The use of a buster vacuum cushion allows optimal positioning of the head for surgery.



Figure 9: The intradermal skin layer results in no visible sutures at the end of the procedure.

1. *Trans-conjunctival enucleation*

The advantages of this technique are that the periorbital fat and extraocular muscles are retained, which improves the cosmetic result. It is also less traumatic, there is less haemorrhage and better exposure of the optic nerve and orbital vessels can be achieved. A disadvantage is that any infectious organisms in the conjunctival sac will be introduced into the orbit once the conjunctival space is breached. Another disadvantage is that more tissue will be left behind, which is clearly not desirable where there is extension of tumours cells.

A lateral canthotomy is performed to increase surgical exposure. An eyelid retractor may be used when this is preferred by the surgeon, although this is not essential. The third eyelid is grasped and removed, along with the gland of the third eyelid, using tenotomy scissors. A 360° conjunctival incision is made 2-3 mm posterior to the limbus and extended posteriorly, bluntly dissecting the conjunctiva and Tenon's capsule from the globe. Just enough conjunctiva should be left attached posterior to the limbus for grasping with a forceps, to facilitate manipulation of the globe. The extraocular muscles are transected close to their insertion on the globe. The optic

nerve and associated blood vessels are clamped with a curved artery forceps. The globe is removed by sectioning between the forceps and globe, taking care not to puncture the globe. The eye is placed in fixative. The clamp is left in position while the eyelid margin (approximately 2-3mm) is removed, taking care to also remove the eyelid margin at the medial canthus, where the eyelids are more closely attached. Where possible, the optic nerve and ciliary blood vessels are tied with a ligature. The purpose of this ligature is both to reduce haemorrhage and to close the nerve sheath which directly communicates with the central nervous system, preventing reflux of blood or leakage of cerebrospinal fluid. However, this is not always possible, in which case the clamp may be removed and the orbit packed with a sterile swab while firm digital pressure is applied for five minutes. The swab is removed and observation for further bleeding is made, but usually it has stopped at this point apart from mild capillary seepage. Conjunctiva should be removed to reduce the possibility of mucocoele formation. The orbit is usually closed in three layers. The first layer is adjacent to the periorbital rim and is used to close as much dead space as possible. The second layer is at the level of the Tenon's capsule and conjunctival remnants, and the third layer is an intradermal layer (Figure 9). A continuous suture pattern may be used and this will reduce overall anaesthetic time, although dehiscence is more likely than with the simple interrupted pattern. Some veterinary surgeons prefer skin sutures (for example nylon or silk sutures) in the eyelids.

2. *Trans-palpebral enucleation*

This technique is the preferred technique where there are neoplastic cells or infectious organisms in the conjunctival sac, or where there is globe rupture or threatened globe rupture. The disadvantage of this technique is that a larger void remains creating dead space, making it more difficult to suture, and a larger orbital depression is left afterwards.

This technique involves removal of the globe and all of the attaching conjunctiva, third eyelid and extraocular muscles, along with the lid margins. The eyelids are sutured together in a continuous pattern. A full thickness encircling incision approximately 2-3mm from the eyelid edges is made around the palpebral fissure with a scalpel blade, and the eyelids may be grasped with Allis tissue forceps on either side in order to provide easier manipulation. Allis tissue forceps alone, without suturing the eyelid margins, may provide satisfactory traction. Blunt dissection is carried out as far as the orbital margin and sectioning of the lateral and shorter medial canthal ligaments is required. Once the eyelids are mobile, gentle traction is applied and dissection is continued caudally outside the extraocular muscles, taking care not to puncture the conjunctival sac. Attempts to place a ligature around the optic nerve and associated blood vessels are made as in the trans-conjunctival method, although visualisation is not as good. After removing the globe, the periocular tissue should be carefully dissected from the sclera before placing it in fixative. Closure is



Figure 10: Silicone prostheses of various sizes, sterilized and ready for use.



Figure 11: In this canine patient, the left eye had been eviscerated and a silicone prosthesis placed four years previously.

achieved as for the trans-conjunctival technique, although there is less tissue available for the deeper layer.

3. Exenteration

This technique involves removal of the globe and as much of the orbital contents as possible. It is an extension of the trans-palpebral approach, after which any remaining orbital connective tissue or fat are removed.

4. Ocular prosthesis

Ocular prostheses offer owners an alternative to traditional enucleation techniques.

A spherical silicone prosthesis (Figure 10) can be inserted into the orbit to improve the cosmetic outcome by reducing the hollow depression which is visible behind the eyelids after the traditional techniques. Alternatively, the prosthesis can be inserted into the globe after its contents have been removed. These prostheses are available in a variety of sizes and the appropriate size is chosen for each animal. The owners are generally more pleased with the cosmetic outcome, although it makes less of a difference to the animal. They have a potential value in young animals where skull development relies on the presence of a globe.

(a) Intraorbital prosthesis:

Enucleation is carried out as above by the trans-conjunctival technique which results in more tissue being left behind to create a seal over the implant. Closure of the orbit is achieved in three layers. The first layer apposing the tissue close to the orbital rim is commenced loosely. Once the suture has progressed one third of the distance to be closed, the implant is inserted into the orbit (after sterilising it and rinsing it in sterile water) beneath the continuous suture. The suture is tightened which holds the implant in place while the remainder of the continuous suture is placed. It is important to close the orbit in at least three layers over the prosthesis to ensure the best possible seal.

(b) Scleral cup prosthesis:

In this technique, the entire contents of the eye (vascular coat, lens, retina, vitreous etc.) are removed (evisceration) and a spherical silicone implant is placed within the scleral shell. There are ethical arguments for and against doing this procedure because of potential complications after surgery. It is a valuable procedure for owners who would have their animal euthanised rather than lose the globe / globes completely. Not all cases are suitable for this procedure. It is contraindicated where neoplasia or infection within the eye are suspected. It is also contraindicated with pre-existing corneal disease. The intact globe is not available for histopathological examination, which may result in the failure to diagnose the underlying problem. Tear production can decrease after this procedure. There is a risk of corneal ulceration and of delayed corneal healing, which could lead to globe rupture. Occasionally, the sutures may dehiscence and the implant may be extruded. There will be ongoing care required and there is a greater risk of complications. The advantages of this procedure are that it is less traumatic overall, and a mobile globe and adnexa are maintained. Some owners prefer this technique as they feel that they do not want to reduce the emotional bond with the animal's appearance. However, the appearance of the eye will be different, and ideally the owner should be shown a photograph of the typical outcome to ensure that they find it cosmetically acceptable (Figure 11). Evisceration is a difficult technique which should only be performed by veterinary surgeons familiar and competent with the procedure.

Topical anaesthesia is useful before starting the procedure. A large incision is made dorsally under the conjunctiva and Tenon's capsule approximately 4mm from the limbus and extended approximately 140°. The sclera is incised full-thickness, taking care not to incise the uvea where possible. Viscoelastic solution may be injected posterior to the corneal endothelium to try to minimise trauma. The prosthesis itself will later cause trauma anyway, but that is a more even spread of pressure. An evisceration scoop, spay hook, or two alternating artery forceps may be used to tease the uvea from its attachment. The lens and retina also come away with the uvea. The ocular contents can be submitted for histopathological examination to assess the presence

of infectious organisms and neoplasms, although such conditions could be easily missed due to the nature of the specimen collected. The inside of the eye is irrigated with sterile solution and haemorrhage is expected. Closure of the sclera is achieved by a continuous layer of 4/0 absorbable suture material, and over this another layer of 6/0 absorbable suture material is used to close the conjunctiva. The eye is normally red after this procedure as it induces intraocular haemorrhage. This gradually fades but the cornea then begins to vascularise as it no longer has nutrients supplied to it by the aqueous humour. Usually white fibrosis and red vascularisation occur initially. Usually (but not always) the cornea later pigments and the cosmetic appearance is improved.

Finally, when performing enucleation, it is important to realise that:

- The lacrimal gland is generally not removed because of its position. While in theory this would lead to a build up of tears within the orbit, this rarely happens. It is essential to remove the gland of the third eyelid along with the third eyelid.
- Packing material should not be required within the orbit. It could allow infectious organisms access to the orbit and is very uncomfortable for the patient.
- A stent may be applied to provide some pressure if there is seepage after wound closure. This is provided by a rolled up cotton swab, which is secured using a horizontal mattress suture (**Figure 12**), which is removed the following day.
- Except in cases of enucleation due to known trauma, all enucleated eyes should be submitted for histopathological examination. It affords a chance to obtain an accurate diagnosis, and therefore could potentially provide very valuable prognostic information for the other eye, as well as for the body in general. It benefits us by allowing us to learn more about the condition, benefits the animal in providing the most appropriate treatment and benefits the owner who can be given most accurate information about the condition and know they have done the best thing for their pet.

Post-operative care

An Elizabethan collar should be worn by the patient until the eyelids have healed well (seven to 14 days post-operatively) to protect the surgery site and prevent self-trauma.

It is usual for some orbital swelling to occur, usually due to haematoma formation underneath the sealed eyelids. This usually resolves in three to five days. Warm compresses may be applied by the owners if this seems to give the animal some relief.

A tear duct connects the orbit to the nares, and therefore a small amount of bleeding (usually serosanguinous in nature) from the ipsilateral nostril may be observed in the first three to four days after the procedure.

Post-operative analgesia, in the form of non-steroidal anti-inflammatory drugs, should be provided for approximately



Figure 12: A stent was placed on the orbit to apply pressure to reduce post-operative bleeding.

five days after surgery.

A short course of post-operative antibiotics are normally prescribed as it is impossible to maintain a completely aseptic field throughout.

In cases where non-absorbable sutures have been used in the eyelids, these are removed 10-12 days following surgery.

There can be complications associated with enucleation.

These include:

- Cardiac bradyarrhythmias as a result of the oculo-cardiac reflex. Stimulation of the vagus nerve can be avoided or minimised by gentle globe and tissue handling.
- Intra-operative bleeding. This may arise from the optic blood vessels. Usually packing the orbit with a swab and applying digital pressure for long enough (five minutes or more) will stop the bleeding. Bleeding can also occur from the angularis oculi vein when the eyelids are being removed. It is situated below the medial canthus.
- Post-operative bleeding. Eyelid closure provides a seal to contain any further haemorrhage. However, if bleeding is extensive, the orbit can swell and blood may escape. For small or unwell patients, the potential blood loss may be significant.
- Infection.
- Dehiscence of the surgical wound.
- Cyst or mucocoele formation due to inadequate resection of conjunctiva or gland of the third eyelid. Build-up of lacrimal secretions can lead to sinus formation.
- Orbital emphysema.
- Blindness of the contralateral eye, as mentioned below in the discussion of feline enucleation.

When it comes to enucleation in companion animals, blindness is well tolerated. Animals with vision in one eye cope very well and generally behave completely normally. They do lose their binocular vision which does alter their depth perception (stereopsis), although they do retain a limited ability to judge depth using other visual cues. In addition, a variable degree of orbital depression is present, but this is usually cosmetically acceptable and rarely causes the animal any problem. When the hair regrows, the depression becomes less obvious.

Species variations

Cats

This procedure needs to be approached with more caution than the same surgery in a dog. The optic nerve of the cat is very short and therefore the optic chiasm is positioned close to the eye. Extra special care must be taken to avoid traction of the optic nerve, as this force is transmitted to the optic chiasm and may damage the contralateral optic nerve. This could result in blinding the contralateral eye, which has a fixed dilated pupil after surgery. It is recommended that the trans-conjunctival method is used in cats to minimise this risk, and that narrow curved haemostats are used to clamp the optic nerve.

Another consideration is that a small percentage of cats which suffer lens trauma may in later years develop an intraocular sarcoma. This is a malignant tumour which is aggressive and may invade the optic nerve and thus spread. In order to prevent this aggressive tumour from developing in later life, enucleation could be offered to all cats with trauma resulting in the lens capsule being breached.

Rabbits

The preferred technique for enucleation in rabbits is the trans-conjunctival method. This is because it disturbs minimal tissue and allows for good exposure to visualise the optic nerve and orbital blood vessels. Rabbits have a deep orbital sinus, which can bleed very heavily if it is damaged. This bleeding could have fatal consequences.

Birds

The eyes of birds are anatomically different to dogs and cats in that they contain bony scleral ossicles. The orbit is also very small relative to a large globe. It provides very good protection to the eye which reduces surgical exposure. A trans-aural approach may be used in owls which have large external ear openings. This technique allows for preservation of the globe for histopathology. Another method is a lateral approach with a globe-collapsing technique. As for cats, the optic nerve of birds is very short and special care must be taken to avoid any excessive traction. Meticulous attention to haemostasis should be made.

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