Hospitalisation, Anaesthesia & Orthopaedics

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1. INTRODUCTION

Deer values remain high. Large sums are being paid for imported deer, both red and Wapiti. Large sums are being paid for deer of endogenous origin for which the farmer has kept productivity records or which are in dam and sire proving schemes. More farmers are recording stock performance. The national deer recording scheme "Deerplan" will further highlight individual deer of exceptional genetic merit, and therefore monetary value.

Predictions are for a steady growth of the deer industry as more farmers look to diversify and existing deer farms expand. Currently demand for breeding stock is high. Many deer enclosures are under-stocked. Many investors in the industry have managed to regain their original invested capital and can afford to invest further in the industry.

The Game Industry Board is actively researching markets for venison. Indications are those of a considerable potential market for this product. The current farmgate returns for venison considerably exceed those of sheep and beef meats, and are likely to continue to do so.

Considering these facts it is probable that the value of individual deer particularly the breeding stag and hind, will remain high. Thus economics which currently allow intensive investigation of problems and treatment of individual deer will almost certainly continue into the future. The veterinarian must therefore adopt an "intensive care" attitude toward the individual animal which has not been a feature of clinical practice for other livestock farming enterprises. Further, the deer is usually of a size that does not prevent for physical reasons the application of sophisticated techniques for surgical and/or medical treatment of a number of conditions.

This paper discusses some of the techniques used at the Massey University Veterinary Clinic for handling of deer which require hospitalisation.

2. INDICATIONS FOR HOSPITALISATION

Deer may need to be confined for a large variety of conditions, both medical and surgical. It is often expedient to confine a sick deer if daily treatment, or assessment of progression of the condition is desired. It is essential that infectious disease cases are isolated. It may be expedient to retain deer with medical conditions such as foot problems in a clean dry environment for treatment, rather than return them to a wet, muddy environment. Deer with some types of surgical or sutured wounds should be kept in a clean dry environment. Confinement will help prevent wound breakdown or infection, and facilitate dressing changes. Confinement will also prevent victimisation of a sick or incapacitated deer by herd mates. However, the most common reason for hospitalisation is for recovery from trauma involving limb fractures.

3. Examination and On-farm care of injuries

The immediate concern is to prevent a fracture from becoming compound, particularly those of the distal limbs. This may necessitate immediate tranquillization of a fractious deer. Careful handling is necessary.

Remember, further trauma may also result in avascularity of distal tissues. The area should be support bandaged immediately using a Robert Jones bandage or similar if radiology and/or surgery are likely to follow. Some splint support may also be applied if considered appropriate.

Compound fractures should be cleaned and then bandaged. Systemic antibiotic should be given immediately. Obviously, if it is immediately apparent that amputation is the only course, bandaging is unnecessary.

The limb distal to the fracture should be checked for vascularity and innervation.

4. Transport to the clinic

Care must be taken to avoid further soft tissue trauma during transit. Very young deer are best transported simply nursed in a car with or without a blindfold. It may be appropriate to place the small deer in a sack with head exposed.

Adult deer will need to be transported in normal deer transport. If tranquillized or recumbent, sawdust provides the best floorcover. Alternatively a thick cover of straw or hay will suffice. The vehicle must be driven quietly and smoothly.

5. Hospitalisation

The indications for hospitalisation have been discussed above (2).

(i) Facilities: Confinement can be in clinic facilities such as a modified horse loose box, or for small deer, modified small animal runs or cages. More specialised handling facilities would be needed for larger stags. Alternatively, the deer can be transported back to the farm after surgery or treatment and confined in a suitable deer pen. Pens should have no protruding objects that may result in injury to the deer. It may be useful to have a crush gate in a pen to help confine a deer.

ii) Flooring. The area should have a washable floor, preferably concrete. Clean untreated sawdust approximately 250mm deep provides the best footing. It is essential to provide firm footing following orthopaedic surgery to avoid undue stresses on plates, splints or casts when the animal regains a standing posture.

Straw bedding can be used when limb injuries are not involved, but there remains the risk of slipping and initiation of further injuries such as a dislocated hip.

iii) Lighting. Natural or artifical lighting is needed. We have experienced little difficulty housing deer in well lit environments.

iv) Feed and watering utensils. These should be placed near the doorway. **They should be removed before an attempt is made to catch and restrain the deer.** Injuries may result if buckets, feed bins or troughs are present when deer are restrained for examination or treatment. An alternative is to build feed and water containers into a recess in the wall. However, mobile containers are needed for recumbent deer.

v) Feed. Confinement often requires a change in diet from pasture usually fed on the farm. Initially the appetite of the deer is disminished because of the stresses of the confined environment and manipulations and this may be exacerbated if the deer is not accustomed to accepting a concentrate diet. Only small quantities of concentrate should be made available initially. Fresh-picked grass may encourage the deer to eat. Chopped hapy (meadow or lucerne) appears more acceptable than unchopped. Peavine hay enjoys the greatest palatability to deer and therefore is the roughage of choice. Silage can be given. Maize, barley, peas, meal mixes or deer nuts are all suitable feedstuffs.

It usually takes 3-4 days for a deer to regain its appetite after adapting to the environment and new diet. We feed chopped hay ab lib. Concentrates supply approximately half the nutritional requirement.

vi) Handling. Housed deer startle easily because of their temperament and because they cannot see people approaching. It is therefore advisable to give vocal warning of intention to enter the pen. A deer on its own is flighty and therefore it is most useful to recruit a pet deer or two, or a particularly quiet deer, to provide company for the patient. Most farms have a suitable specimen. The benefits of having extra deer are considerable.

Initially the deer is usually very apprehensive and flighty. It may take 3 days before it becomes accustomed to the presence of people. Only quiet, deliberate and slow movements should be made. You should talk to the animal the whole time. Do not be in a hurry to restrain the deer: 10 minutes spent in calming the deer before restraint may prevent exacerbation of injuries, bending of plates or rupture of suture lines, and prevent unnecessary flight by the patient.

vi) Stags. Stags are aggressive for the duration of the rut and for some weeks either side. Even at other times I believe that a confined stag must be regarded as untrustworthy. Even a stag in velvet can become aggressive if confined. A stag on its own is always more dangerous than when it is with other deer. If a stag is to be confined, female deer rather than male deer should be provided for company because stags tend to be agggressive toward one another, particularly when confined.

It is difficult to physically restrain a stag because of its strength. Therefore a facility must be provided in which the stag can be restrained for treatment and/or examination while being without danger to personnel. This will usually need to be provided by a crush gate. Hydraulic or manual crushes that restrain the deer with its feet off the ground would not be suitable for most limb fracture cases, but would be suitable for many other cases.

vii) Duration of Hospitalisation. Deer should be housed no longer than necessary. At Massey deer have been hospitalised for up to 5 months without serious problems. However, return to the herd becomes more difficult for the deer, particularly adults after a long periods. They may be victimised by previous herdmates. It may be necessary therefore to place the deer with a mob of a younger age group. A deer which has been housed for long periods may develop the behavioural characteristics of a pet deer and some farmers regard these as a nuisance.

6. Problems with Hospitalisation

The problems experienced at Massey include:

i) Further injury
Bending of a bone plate when the deer was recovering from surgery. The reason was that no sawdust was available for the floor and the hind slipped on the concrete. The prevention is obvious.

One deer fractured a tibia above the plate used to repair a fracture, when its leg was caught under a feed trough. The prevention is to site feeding utensils in a situation where they can be removed, or design the room with feed and water in recesses in the wall.

ii) Fright/Flight
During the first 2-3 days some deer exhibit a greater flight response than others. Quiet and careful handling is essential. Flight is decreased when more than one deer is confined.

iii) Administration of drugs
Deer become "needle-shy" with repeated injections. Care must be taken to be gentle with administration of drugs.

iv) Aggression
Adult hinds occasionally begin to resent human intrusion, particularly if repeated injections are necessary. They may bite or strike with front or back feet. Such deer should be approached quickly upon entering the pen and restrained. Handling should be kept to a minimum. Protective headwear would be advisable. These animals rarely strike a competent and confident handler who assumes dominance, but inflict rapid punishment to handlers who lack confidence.

Stags present a problem when hospitalised. The facility must be designed to allow the deer to be restrained by means other than direct physical handling. A crush gate should be adequate. Similarly, large wapiti hinds may present problems for physical restraint because of temperament and sheer strength.

Conclusions

Our experience has shown that deer are amenable to hospitalisation following injury or illness. Such confinement may be in a clinic facility or in the farmer's deer yard. Care must be exercised with injury cases to avoid further trauma during examination, transport and pre-surgical handling. Anaesthetic techniques differ little from those applied to other domesticated ruminants. Recovery from anaesthesia should be in a quiet pen preferably with sawdust flooring. Problems of flight and inappetence when the deer are first hospitalised can be overcome by time and careful handling. Injections and handling should be kept to a minimum for deer housed for long periods since they may become aggressive in response to over-handling. Having a pet deer or two with the patient is particularly beneficial.

7. Anaesthesia

The following is a description of techniques used at the Massey University Veterinary Clinic.

(i) Assessment of anaesthetic risk

Deer are flighty animals and even farm reared deer suffer severe stress when away from their normal environment and when handled by people. Their heart rate, respiration rate and often their temperature will rise as a result of these factors. Stress causes an elevation of haemoglobin, PCV and white blood cell count. Deer readily dehydrate and stress and shock exacerbate this problem. Adrenaline effects on the heart may cause problems during anaesthesia. Thus the risk of anaesthesia in deer is probably higher than in many other species.

Deer should be handled deliberately and with confidence prior to anaesthesia. An apprehensive handler results in an apprehensive animal. A pre-anaesthetic examination is the same as applied to other animals. Deer should be depirved of food but not water for 12-24 hours before anaesthesia, but this may not be possible in emergency situations.
Of approximately 30 general anaesthetics performed on deer at Massey, only one loss was encountered. The loss occurred in a four-month-old red female which was "berserk" before it was even examined on the property. It developed a hyperthermia and died 36 hours after surgery with signs of a stress-induced myopathy.

ii) Premedication

We invariably use Rompun at a dose rate of 0.4mg/kg which will cause recumbency in about half the cases. The temperament of the deer should be assessed and a higher dose given to a more flighty animal. The deer is then left alone for 10-15 minutes and if not recumbent, is gently held for a short period and this often results in recumbency. The deer is carried onto a trolly, either standing or lying and transported to the surgery.

iii) Induction of anaesthesia

The deer is restrained in lateral recumbency on soft mats and a blindfold is placed over its eyes. In our experience the premedicated deer rarely struggles during this procedure. The deer is given time to "relax" while the neck is clipped and an indwelling jugular catheter inserted. Our inducation agent of choice is glycerol quaicolate (GG) as a 5% solution in saline. Thiopentone (about 3%) is sometimes mixed with GG. GG is infused via a flutter valve and is given to effect. Care must be taken to monitor the effect of induction. In our experience the palpebral reflex is not a particularly useful indicator of depth when GG alone is used. I rely on assessment of jaw tone. When the jaw appears relaxed, infusion is stopped and intubation attempted.

For an average (90kg) hind, approximately 150ml of the 5% GG solution is usually adequate. One hind which was given approximately 250-330mls began to undergo muscle tremors. The eyelids began to twitch, the pupil dilated and the eyes rolled up - all signs of excess GG. We now intubate after only a "small" dose of GG.

Intubation requires a long endotracheal tube with a stilette, as the larynx is well back. A long laryngoscope is used in small deer but usually the larynx is palpated externally and the tube guided in carefully without a laryngoscope.

iv) Maintenance

Once intubated the deer is maintained on either halothane/oxygen or halothane/nitrous oxide/oxygen. The former is usually used. Initially 2-3% halothane is given to complete induction and once adequate depth is achieved, 1% or 1·5% halothane is used for maintenance with an oxygen flow rate of 2 litres/minute for adult deer. We usually use a Boyle apparatus with a closed or semiclosed circuit. A T-piece is used with small deer.

Depth of anaesthesia is gauged by the palpebral reflex, anal reflex, withdrawal reflex by pinching the interdigital skin, or by pinching the ear. Response to surgical incision is the final test of adequate depth. The usual parameters are monitored.

Few problems have been encountered. Occasionally a deer will have a very low respiratory rate during surgery but positive pressure ventilation is generally not necessary. Occasionally the heart rate will fall to below 40/minute. Atropine has been used on occasion. Rumenal tympany occurred in one case which was not deprived of food prior to anaesthesia.

v) Supportive therapy

Deer are always given warmed intravenous fluids during surgery to help avoid surgical and post-surgical shock. Fluids are particularly important in deer where there is a risk of toxaemia e.g. caesarian with emphysematous foetus, infected wound repair. A choice is made between a balanced electrolyte solution and lactated ringers solution. One-four litres is given depending on the size and state of the deer and the duration of surgery.

vi) Anaesthesia of the neonate and small calf

The risk of anaesthesia of small calves (neonates to 20-25kg) is high. Experience of others has shown that problems can occur after intravenous agents are used for induction.

Deer of this size usually do not struggle very much and can be held quietly in lateral recumbency on a table without premedication. We use a mask with a mixture of halothane and nitrous oxide for induction. The deer may struggle upon application of the mask, but quickly relax. Intubation is carried out using a laryngoscope and anaesthesia is maintained using halothane/oxygen. An open T-piece system is used.

The major problem we believe with very young deer is hypothermia. Our experience has shown that even with electric blanket heaters the temperature falls often below 36°. In one case involving 3 hours of orthopaedic surgery on a 1-day-old calf, anaesthesia as described was uneventful. The temperature fell from 39°C to 36°C over 1·5 hours and then stabilized. However, recovery from anaesthesia was slow and the palpebral, pupillary and swallowing reflexes were sluggish. The calf began to shiver 0.75 hours after anaesthesia ceased but then the heart rate and respiration rate slowly deceased and agonal head and body movements began. Despite the application of ventilation and administration of adrenaline, the calf died about 1·5 hours after surgery. We now believe that 36°C is too low a temperature for such young deer. Every effort is now made to keep the temperature up as close to the preoperative temperature as possible. This can be achieved by heating the surgery and wrapping the trunk in cotton wool and electric blanket. Problems of surgical access will arise in some situations!

vi) Post anaesthetic care

After the endotracheal tube is removed the deer is placed back in the stall in sternal recumbency and observed frequently until standing. Food and water is given immediately postoperatively. In cases of orthopaedic surgery, we often sit with the deer and assist as it stands for the first time to avoid unnecessary strain on casts, plates, etc. We occasionally place a deer in a sling if we want to restrict movement.

Care must be taken in assessing the rate of recovery from anaesthesia. Some deer play "possum". One deer showed all the signs of a slow recovery after a caesarian - no palpebral reflex, failure to chew or swallow. No movement, was observed while recumbent on the operating table, yet when an attempt was made to move her, she leapt up and ran out the surgery door despite attempts to restrain her. She was eventually recaptured in the washroom. We now place the deer in the recovery room shortly after disconnection from the anaesthetic machine.

Management of Cervine Trauma

When one looks back at John Hunter's comments in the 1981 Queenstown proceedings it appears that the nature of injuries in deer have changed somewhat since then. This is no doubt due to the decreasing impact of live capture on the deer farming scene, the improvement of handling facilities and the increasing domestication of the animals. This year we have noticed a decrease in the number of fractures on our clients farms compared with previous years. It would appear however that the very nature of the animal especially while young means that traumatic injuries will continue to be relatively common. The losses over a 12 month period in a herd of 1890 red deer illustrate this point:-

Cause of death	No.
Injury/misadventure (hinds & weaners)	9
Dystocia (hinds)	3
Yersiniosis (weaners)	4
Calves deaths*	3
Undiagnosied (adult hinds)	3

* all dead calves may not have been found.

So almost 41% of losses involved trauma and as approximately half of these involved limb fractures they become an important consideration.

The information on the types of fractures presented at the Massey Clinic is also interesting.

Cervine fractures presented at the Massey Clinic:

Site	No.
cervical vertebrae	2
lumbar vertebrae	1
mandible	1
scapula	1
humerus	1
femur	1
pelvis	2
radius	2
metacarpus	3
tibia	9
metatarsus	2

So 36% of the fractures involved the tibia and 64% could be regarded as lower limb fractures. These and some of the others should be amenable to treatment with techniques currently being used successfully in other species.

Although it is an anathema to one interested in orthopaedic surgery I must concede that in deer as production animals, there are injuries which can resolved satisfactorily if not treated. The continuing value of individual animals however means that relatively sophisticated treatment is practical. During this presentation I would like to look at these two extremes and the possibilities inbetween and illustrate them with case material. While the number of cases is still small, a study of them allows some suggestions to be made which may help in deciding how best to deal with cervine orthopaedic conditions.

1. Cases which were not treated

   a. Fractures in immature animals

      8 week stag calf, # tibia
      resolved completely over 12 weeks,
      straight limb with normal function.

      stag calf, # metatarsus
      resolved over 6 weeks,
      limb straight.

   b. Fractures in older animals

      Adult stag, # metatarsus
      not noticed at the time of injury
      healed with slight deviation

      Adult hind, # scapula
      displaced and comminuted but no joint involvement
      resolved satisfactorily

   c. Dislocations

      2 hind calves, (both less than 2 months), dislocated hip
      closed reduction, remained stable.

      Yearling stag, dislocated shoulder
      unstable, but resolved.

      Adult hind, tarso-metatarsal luxation
      joint relatively stable, resolved satisfactorily.

If anything can be drawn from so few cases the information suggests that:-

i) Simple fractures, even of the lower limbs in very young animals can resolve if the calves are left undisturbed in the paddock. One must weigh this however, against the chances of the fracture becoming compound, an occurrence which we have experienced at least on one occasion.

ii) Fractures of the major bones of the upper limbs of adults can resolve if they are not too displaced and not too unstable.

iii) Dislocations which are relatively stable when reduced appear to stay that way and resolve.

2. Amputations

One of the features of cervine fractures is the violence with which they are inflicted and so they are often associated with massive soft tissue trauma. The nature of the animal also means that simple fractures very rapidly become compound in the paddock or yard situation. One is often presented with situations where bone fragments are exposed and grossly contaminated or where the limb distal to the fracture has a dubious blood and nerve supply. Under these circumstances amputation is often the only alternative.

The difficulties of managing cervine fracture patients has led to the suggestion that amputation may be the most practical and direct method of dealing with them (Queenstown Proceedings, 1981).

Technique

When amputating the limbs of other species it is usually recommended that the site be as far proximal as is practical in order to prevent the animal attempting to use the stump. Sometimes under field conditions where major surgery is difficult, amputations of the limbs of deer have been performed just proximal to the injury. This may result in a stump which can reach the ground. This stump can become covered with a kerratinised pad and so be relatively functional but its use requires considerable modification of the animal's gait. Such a stump is always susceptible to trauma and protrusion of the bone. For these reasons I believe it is preferable to perform a proximal amputation if possible.

As with other heavily muscled animals it is necessary to ensure that the sectioned end of bone is well covered with soft tissue at the completion of surgery in order to prevent it becoming subcutaneous when muscle atrophy occurs.

The preferable techniques appear to be:-

i) Forelimb, amputation through the shoulder joint and some have recommended removal of the scapular spine. Alternatively, removal of the whole scapula.

ii) Hindlimb, section of muscle and attachments at the level of the stifle and their proximal reflection to allow the femur to be divided as close to its proximal end as possible.

Results

The results of amputations performed at Massey can be summarised as follows:

Age	Sex	Origin	Limb	Outcome
Adult	M	captured	front	Died, 7 days
Adult	F	captured	hind	Died, 3 months
22 month	F	farmed	hind	Euthanasia after rearing a calf
16 month	F	farmed	hind	Healthy after 12 months Yet to prove fertility.
10 month	F	farmed	hind	Reared 1 calf/1 opportunity
5 month	F	farmed	hind	1 calf/2 opportunities
4 month	F	farmed	hind	2 calves/2 opportunities
3 month	F	farmed	hind	2 calves/2 opportunities
3 month	F	farmed	hind	healthy, yet to prove fertility
2 days	F	farmed	hind	1 calf/2 opportunities, dystocia followed by uterine prolapse

The prognosis for survival of newly captured deer after limb amputation appears poor. The stress of capture, surgery and adptation to three limbs is sufficient to explain this. Pat Holmes has three surviving forelimb amputees where the limb was removed when the animals were adult. The two hinds in this group have yet to prove their fertility. In our series the hind which was destroyed had begun weight bearing on the anterior aspect of the remaining hind fetlock presumably after damage to the digital extensors.

The prognosis for future breeding and even long term survival of deer which have lost limbs as adults appears to be open to question. Young amputees however appear to manage well and have a calving percentage similar to normal deer.

3. Cases treated using external fixation

I was able to obtain follow-up on fractures of the metacarpus in an adult hind and stag and of a fractured radius and ulna in an adult hind which had been treated using synthetic casting materials. None of these cases were successful. Fractures of the radius and ulna, metacarpus and metatarsus in calves however, healed satisfactorily after 4-6 weeks in hexcelite casts.

The fact that external fixation has not been particularly successful in adult animals is not surprising. While the new casting materials (Hexcelite, Delta-lite) are light and strong enough and retain their strength when wet the principles of external fixation are difficult to apply to animals such as deer. As the joint above and below a fracture should be immobilised, casts could only be expected to be really effective for fractures distal to the carpus and tarsus. These areas which have very little soft tissue covering in deer are susceptible to pressure problems. Coupled with this, the animal's temperament is such that even when confined it will severely stress a cast and the fracture. Immobilisation of bone ends under these circumstances could well be insufficient to allow healing to occur.

4. Internal Fixation

In the present economic climate this approach is a viable proposition and in my opinion has much to offer when dealing with cervine fractures. We have seen that some fractures in immature animals have resolved when left alone or when cast. The information is insufficient however, to draw meaningful conclusions as to which types of fractures are best handled this way. From first principles, simple relatively stable diaphyseal fractures and non displaced, stable, growth plate fractures would appear to be the best indications for this approach. With comminuted, compound, displaced growth plate fractures or where a joint is involved I believe that internal fixation will give the best chance of a useful future for the calf.

So far as fractures in adult deer are concerned internal fixation does present the possibility of returning both the limb and the animal to complete normality in some cases.

Modern compression equipment is well suited for use in deer and the animals are well able to tolerate the combined challenges of anaestheisa, surgery and infection. The disadvantages of course are the much greater cost of this approach both in terms of the surgery and implants and post operative confinement. It appears that confinement till fracture healing is complete and implants have been removed is necessary even with calves. With stable internal fixation deer will use their repaired limb to bear full weight from the moment they recover from the anaesthetic. This means that implants can be severely stressed and requires that the first principles of stable internal fixation must be faithfully applied, any compromises usually result in disaster. In adult deer we have found it necessary on occasions to provide additional external support at least in the immediate post operative period. This has usually been in the form of a cast with reinforcing splints if necessary.

Cases treated using internal fixation

Immature animals

	Age	Sex	Origin	Fracture	Treatment	Outcome
1.	2 days	hind	farmed	metacarpus, distal tibial growth plate	DC plate, lag screws & K wire	died immediately post op
2.	3mos.	hind	farmed	metacarpus, compound	lag screws & DC plate	died post op
3.	3mos.	hind	farmed	radius	DC plate	plate removed 3 mos. normal function
4.	3mos.	hind	farmed	distal tibial growth plate & tension bands	lag screws, cross pins	pins removed 3 mos. normal function
5.	3mos.	hind	farmed	metacarpus	DC plate	plate removed 3 mos. normal function

	Age	Sex	Origin	Fracture	Treatment	Outcome
6.	2days	hind	farmed	dislocated hip unstable after closed reduction	trochanteric transfer, K wires & tension band	hip remained stable
	Adults					
7.	?	hind	captured	ruptured gastrocnemius tendon	ankylose hock DC plate	fractured tibia above plate, amputation
8.	16 mos.	hind	farmed	tibia, compound, comminuted	lag screws, cerclage wire, broad DC plate	bent plate amputation
9.	16 mos.	hind	farmed	tibia, compound, comminuted	lag screws cerclage wire broad DC plate hexcelite cast & walking bar	plate removed 4 mos. normal function

It appears that if it is practical to apply intensive individual treatment and post operative care many cervine fractures can be handled successfully. Probably the most critical time is that immediately post trauma when further comminution, soft tissue damage and compounding of the fracture are likely to occur.

Acknowledgements
I would like to thank John Hunter and Pat Holmes for making their case records available for inclusion in this presentation.

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