Managing antler problems in deer

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Antlers are one of the most amazing features of the mammal kingdom. They are, in mammals, the fastest growing tissue and the only example of the regeneration of an entire organ. Veterinarians encounter deer as a result of road traffic accidents, as young animals being bottle-reared, or when veterinary problems occur in farmed or park deer or in animal collections. This article aims to provide information about antlers in terms of their growth and associated abnormalities, and discusses the particular issues faced by practitioners when dealing with castrated deer (especially reindeer) and orphan male calves.

Horns and antlers

Ruminants are divided into two principal families:

- Horned ruminants – Bovidae (including sheep, cattle, antelope, gazelle, buffalo, and so on, numbering some 140 species);
- Antlered ruminants – Cervidae (comprising 16 genera and at least 40 species of deer).

Antlers are peculiar to deer and are the most conspicuous identifying features of these animals. Although any animal that grows antlers is a deer, not all deer species grow antlers: for example, Chinese water deer (Hydropotes inermis) (which were introduced to England) do not grow antlers. As can be imagined, there are many variations among the 40 species of Cervidae, including antler growth, so it is not easy to generalise across the family.

Apart from reindeer (Rangifer tarandus) and their New World wild counterpart the caribou, it is usually only male deer that have antlers, although occasionally females of other species, including roe deer (Capreolus capreolus) and much more rarely red deer (Cervus elaphus), can grow them. This anomaly is less rare in species in which antlered females may occur as a result of masculinisation by a male co-twin.

It is generally believed that female reindeer grow antlers as an adaptation to their Arctic habitat. Adult male reindeer and females that are not lactating cast their antlers during the winter. However, lactating females retain their antlers during the winter and are therefore able to defend snow holes and provide access to lichens and other forage for their calves when competing with other members of the herd (Henshaw 1969).

In other species, fully grown and mineralised antlers are hard, dead weapons that can be broken with relative impunity when the male is competing for females and any damage can be made good during the next antler cycle. However, Chinese water deer and muntjac (Muntiacus reevesi) (which have only small antlers) use their canine teeth as weapons.

Although hard antlers are primarily weapons and shields, they also contribute to competitive displays between males during the mating season in a similar way to body size, vocalisations and pheromones (Bubenik and others 1982, Geist 1991, Bubenik 2001).

Antler formation

Antlers grow by endochondral ossification from stem cells derived from the periosteum of an anatomically distinct protuberance of the frontal bone – the pedicle (Mount and others 2006, Napp and others 2006, Rolf and others 2006). An antler may grow at a rate of 2 cm/day in some species and provides a valuable model for the investigation of bone formation (Bubenik 2001).

Antlers are very different from the horns of the Bovidae. A growing antler is cartilaginous and covered by skin that has a large number of sebaceous glands and hair. This skin, known as velvet, is heavily vascularised and, at this stage in the antler cycle, a deer is described as being ‘in velvet’. As an antler hardens, the cartilage ossifies and it becomes, effectively, a dead bone attached to the pedicle.

Hormonal factors influencing antler growth

Because deer evolved to live within northern temperate regions, they are highly seasonal creatures, with their breeding cycles controlled by the seasons and mediated by day length (Lincoln 1971a). Although some species have colonised tropical regions and have, to a greater or lesser extent, lost that seasonality, their antlers have retained their deciduous character. In general, antlers grow during the period of the year when animals are sexually quiescent, and mineralise and die under the influence of testosterone in preparation for the mating season. The hard antler is therefore a secondary sexual characteristic in male animals. It is thought that the role of testosterone in controlling antler cycles is universal across deer species, with the exception of female reindeer, in which oestrogen is the controlling hormone (see below).

Red deer, fallow deer (Dama dama) and roe deer visibly grow their antler pedicles in utero in response
By the end of a male red deer’s first winter, the pedicles will have grown rapidly (having been stimulated by testosterone) and from these the animal’s first antlers develop (which are often just simple spikes) at a rate that is influenced by levels of nutrition. After casting this first set of antlers (usually at about two years of age), the growth of a stag’s adult antlers is controlled by testosterone levels, which, in turn, are controlled by changing day length.

In the spring, as a response to increasing day length, testosterone levels in red and fallow deer decline causing the previous year’s antlers to fall off or ‘cast’. New antlers start to grow immediately and continue to do so very rapidly throughout early summer when testosterone levels are low. With the summer solstice, luteinising hormone levels and subsequently testosterone levels to testosterone, although by birth they may no longer be visible (Bubenik and others 1982, Audenaerde and Simoens 2006). It therefore seems likely that embryonic pedicles in other deer species also differentiate in response to testosterone.
Castration

If male deer are castrated as calves before the pedicle has differentiated, no antlers can be formed. If deer are castrated when they are older and once the pedicle has become active, antlers are formed but, in the absence of testosterone, they remain in velvet and do not harden. If a stag is castrated in the hard antler phase, these antlers are cast, usually after about three weeks, and the animal’s new antlers will remain soft and live, and covered in velvet for the rest of its life. If a red deer stag is castrated when it is growing its antlers, those antlers will remain in velvet and never harden. Thus, castration of an adult stag results in it remaining permanently in velvet.

Castrated red deer that are in velvet will almost always be subordinate to stags that have hard antlers during the winter and, as such, may be excluded from feed sources. However, as they do not suffer the weight loss that intact stags experience during the rut, they are not normally adversely affected and their welfare is not compromised except in the rare situation in which the velvet growth becomes disorganised creating a ‘perruque’ or wig ([Kay and Youngson 1978]). While the formation of large, disorganised perruque antlers [Fig 3a] is rare in castrated red deer, castration of adult roe deer bucks invariably produces such antlers (Fig 3b), which will eventually overwhelm the buck and kill it. Box 1 gives details on how perruques can be managed.

The response of fallow deer to castration is similar to that of red deer and the resultant antlers have been described as ‘antleromas’ ([Kierdorf and others 2004]). Wild whitetailed deer (*Odocoileus virginianus*) have also occasionally been reported to have antleroma-type lesions that are usually associated with alterations in circulating levels of testosterone ([Munk and others 2015]).

Wildlife

**Box 1: Cleaning perruques**

Veterinarians are occasionally asked to treat adult male deer that have been castrated and are consequently in a state of persistent velvet and whose antlers may have developed a haematoma or hypertrophied into a perruque. As early as 1935, it was demonstrated that oestradiol is effective in causing castrated roe bucks to clean the velvet from their perruques ([Biauel 1935]). Subsequently, it was shown that oestradiol is more than 10 times as effective in mineralising velvet antlers than testosterone ([Goss 1968, Bubenik 1990]). The velvet antlers of castrated red deer have also been shown to be readily cleaned using oestradiol ([Fletcher and Short 1974]). However, the more common approach, based on the physiological control of antler growth, has been to administer exogenous testosterone but this will make the deer rut and become aggressive – thus reversing the reason for castration.

For the practitioner, this may be somewhat theoretical since access to depot oestrogens or androgens that will permit levels to be maintained for a sufficient length of time may no longer be available (there are no licensed veterinary preparations and limited human hormonal products available for injection). Published experimental results have usually entailed the use of 100 mg oestradiol-17β implants or 1 g implants or depot injections of testosterone (repeated depot injections of testosterone have been tried). Implants are placed subcutaneously and removed when the velvet has been cleaned. Once the administration of exogenous hormones is stopped, the antlers will be shed (although in some deer this may not be the case) and the new antlers that form will revert to new velvet growth. As it will take some months for the perruque to regrow, this may be considered sufficient therapy.

In Practice November/December 2016 | Volume 38 | 513-519

Wildlife

Fig 1 gives a graphical description of hormonal changes during a male red deer’s year, based on one of the first comprehensive studies of the seasonal reproductive changes in red deer stags ([Lincoln 1971a, b]). Fig 2 illustrates the antler cycle.

Most other temperate climate deer species have similar antler cycles and responses to sex hormones as red deer, although within Britain native roe deer are seasonally different in that their antlers grow during the winter. Tropical species such as muntjac are sexually active all year round.
Wildlife

Box 2: Management of antler velvet lesions (perruques) in castrated reindeer

Sedation, analgesia and careful attention to haemostasis should be performed when removing all or part of a reindeer’s antler that is affected by perruques. It is important to weigh the patient accurately before administering drugs and not to guess the bodyweight. Care must also be exercised in the handling of the deer – some are halter trained but others are challenging to handle.

Sedation

A combination of intramuscular xylazine and ketamine (0.3 mg/kg and 0.5 to 1 mg/kg, respectively) should make the animal recumbent. However, it may be possible to use intravenous medication such as 0.075 mg/kg xylazine with 0.1 mg/kg diazepam followed by intravenous ketamine, as needed, in quiet deer that are accustomed to being handled.

In a hospital situation, it is possible to protect the airway from regurgitation using endotracheal intubation and to use mixed air delivery throughout the procedure together with isoflurane if required. However, such equipment will not be practical when using propane disbudding irons to cauterise blood vessels.

If inhalation anaesthesia is not employed, there may be a need for topping up with intravenous ketamine at 1 mg/kg.

Sedation can be reversed by the intramuscular administration of atipamezole.

Analgesia

Intravenous meloxicam at 0.5 mg/kg and a ring block with procaine should provide sufficient analgesia.

Haemostasis

A tourniquet can be applied to the base of each antler at the start of the procedure. For significant haemorrhage, haemostats are used to handle blood vessels by twisting and leaving them on, as in cattle. For small bleeds, a propane disbudding iron can be used.

Antibiosis

Intramuscular administration of a penicillin/streptomycin combination for three days can be used to provide antibiosis. Wounds can be dressed for three days can be used to provide antibiosis. Wounds can be dressed and a ring block with procaine should provide sufficient analgesia.

Non-hormonal factors influencing antler growth

Deer often grow asymmetric antlers, usually contralaterally, as a result of lameness or amputation (Marburger and others 1972). The mechanism for this is unknown, although it has been suggested that the mechanics of limping might be a factor (Davis 1983). Parasitism or other systemic disease may also stunt antler growth, and it is not uncommon for individual deer to occasionally clean or cast their antlers at abnormal times for no apparent reason.

Fractures

Deer of all species may fracture their growing antlers, creating a substantial haematoma that will eventually mineralise, but unless the broken antler is endangering an eye, no veterinary intervention is likely to be necessary.

Fractures of hard antlers are extremely frequent and, provided the fracture is above the coronet, no action is necessary. If the pedicle is fractured and the antler (or part of it) remains, it might be necessary to tranquilise the animal and saw off the hard, insensitive structure to remove the weight. This will normally allow the pedicle to heal but may mean that subsequent antlers do not grow in their correct position. In such cases, it may be worthwhile to remove the pedicle to prevent any subsequent antler growth. The permanent prevention of antler growth by amputating the pedicle in farmed red deer calves has been shown to be effective (Blaxter and others 1988); disbudding has also been reported but is not commonly practised (Hamilton and others 1993).

It should be noted that the removal of growing (velvet) antlers is illegal in the UK, but velvet antlers can be removed by a veterinarian on veterinary/welfare grounds following suitable analgesia/anaesthesia.

Reindeer

In reindeer it is not just the male animals that grow antlers – females do as well, and this growth is controlled by oestrogen (Lincoln and Tyler 1999). When intact adult male reindeer cast their antlers in early winter they become subordinate to lactating females and to younger males that retain their antlers for longer. The antler cycle for male and female reindeer is illustrated in Fig 4.

Castration and its effects

The castration of reindeer to prevent rutting activity is normal practice among those peoples in the Arctic who use reindeer for pulling sledges, riding or meat. Traditionally, this is performed by biting the spermatic cord to crush it and destroying testicular tissue by manual pressure. Reindeer calves develop pedicles at a very young age (Blake and others 1998) and castration, even of very young calves, is unlikely to prevent antler growth and perruque formation. Even when more conventional castration involving removal of the testes is carried out in reindeer in Arctic habitats, the antlers of castrates are normally cleaned and cast during the winter. It is thought that this is a response to the cold during the winter and also to a nutritional winter deficit.

Castrates among the free-ranging herd of reindeer in the Cairngorms in Scotland also clean and cast their antlers (Smith, personal communication) but the mechanism is thought to be via a response to adrenal steroids, probably...
corticosteroids (G. Lincoln, personal communication) rather than due to the cold and nutritional deficits.

Reindeer kept further south in the UK and used for Christmas displays in England respond differently to castration: they do not normally clean and cast their antlers and they frequently develop perruques. In the absence of available depot steroid preparations, treatment is usually by surgery (Box 2).

**Fibropapillomatous growths**

On some holdings across England and Wales, castrated reindeer have been reported to have unusual large, fibropapillomatous growths on the velvet. Initial investigations sought to establish an infectious viral cause but none was found (Foster and others 2013). These lesions may be similar to the perruques seen in castrates of other deer species (Fig 5). Female reindeer do not appear to develop such lesions and entire males rarely do, so it is likely that these are an unusual and uncommon manifestation of the complex interplay between antler development and endogenous sex hormones. Such lesions would probably be capable of being cleaned under the influence of exogenous hormones but, as yet, no treatments appear to have been effective and the limited number of drugs available leaves surgery to remove part or all of the antler as the only practicable option. Some animals can have such large lesions that surgical intervention (Box 2) may be necessary to avoid secondary bacterial infection and the risk of fly strike. It is unclear whether lesions recur every year in all cases.

**Non-surgical treatment for antler control**

At the time of writing, the authors are not aware of any reliable data on non-surgical treatment options that result in antler control in castrated reindeer, although exogenous testosterone, oestrogen or corticosteroids are likely to cause antler hardening. The normal signal for antler shedding in species other than reindeer, as noted earlier, is a decline in the concentration of circulating testosterone, which permits new antlers to start growing. Female reindeer antlers are controlled by oestrogen and oestrogens may have a minor secondary role to play in the antler cycle of male reindeer (Bubenik and others 1997). Therefore, giving testosterone or oestrogen could help in castrates that fail to harden their antlers. However, control of the reindeer antler cycle is more complex than in red deer and involves oestrogen and prolactin and there is much debate about what endogenous concentrations of testosterone are required to regulate these processes. In addition, as mentioned above, there is evidence that castrated prepubertal calves will still go on to grow normal antlers and shed them as part of the cycle, albeit with time delays for shedding in a few cases (Lincoln and Tyler 1992). Similarly, in older castrates the cleaning of the velvet may be protracted and antler shedding delayed compared with entire males (Lincoln and Tyler 1994).

Hormonal intervention in deer to control the antler cycle has been used in a variety of deer species but in reindeer there are only a few formal detailed studies of the influence of hormones on the antler cycle. Consequently, it is difficult to be sure of the optimum dosing regimen for managing antler problems in castrated reindeer. Any exogenous treatment would need to exceed a threshold dose for a sufficient period and, given that a normal hormonal environment will not have preceded this, adequate resolution of such problems is recognised as a significant challenge. (Sometimes, in the long term, sepsis and fly worry become serious secondary problems if the new growth continually fails to harden.) The dose may also cause the recipient to come back into the rut and potentially lead to aggressive behaviour.

In practice, despite giving testosterone injections, there are reports of attempted treatment failing. It is likely that a significant threshold concentration of circulating testosterone for a sufficient period (perhaps two to three
weeks] to enable mineralisation was not achieved. There is a report of the off-label use of two 2.5 ml intramuscular doses of a 50 mg/ml injection (ie, 125 mg) of testosterone roughly three weeks apart (since such solutions are likely to have an active period of up to 28 days) but this was ineffective and it is possible that the dose was too low for a reindeer bull, which is likely to weigh about 150 kg (weight can vary hugely). More encouragingly, there is a report of 250 mg testosterone being administered intramuscularly as a one-off treatment; this eventually proved effective but it is likely that repeated (and perhaps slightly higher) doses would have given a better result. Thus, one option for successful management of antler problems with castrated reindeer is to use approximately 10 ml of a 50 mg/ml sterile, non-aqueous solution of testosterone, possibly with a second dose three weeks later if there is no initial effect.

Alternatively, silastic tubing implants containing oestradiol or testosterone could be administered in June and removed in October, although the optimal dose of either hormone for this mode of treatment is unknown (and subject to the availability of products). Experimental work undertaken in red deer has been conducted using subcutaneous implants of crystalline testosterone – normally 1 g implants that are estimated to release 2.5 mg testosterone per day or silastic implants – although, again, giving large doses of testosterone to castrated males may induce aggressive behaviour in the recipient. Consequently, the use of 100 mg oestradiol-17β implants releasing 0.25 mg/day may be preferable. (Both of these hormones took three to four weeks to initiate antler cleaning in red deer.)

Female reindeer antler cycles have been controlled experimentally by implanting oestradiol into reindeer in velvet to clean the antlers and removing the implants four months later to induce antler casting (Lincoln and Tyler 1999). Oestradiol is less likely to stimulate aggression than testosterone.

Any hormonal treatments must be accompanied by the usual off-label use warning according to the prescribing cascade principles (and, if products do not have an authorisation for use in any food-producing animals, the consequent prohibition of treated animals from entering the human food chain), with the informed consent of the owner and noting that at such a dose there may be unwanted side effects that might include, as a minimum, hair loss at the injection site. Injecting too large a volume of an oily solution at one site may be a cause for concern.

Bottle-raised deer
Veterinary surgeons are frequently asked what can be done to prevent bottle-raised, orphan male deer becoming dangerous as they mature. This is a very real concern since tame male deer that have lost their fear of people (especially if they have become imprinted on their carer) are extremely dangerous and can cause serious injuries and fatalities. By castrating a calf before the antler pedicles become visible, no antlers can be grown in the animal appears morphologically similar to a male. It is very strongly recommended that male red, roe or fallow deer orphans are castrated as calves. As reindeer are semi-domesticated they pose less of a risk but it would be advisable to ensure that intact male reindeer in hard antler are not used in petting collections. Intact male reindeer used in Christmas displays will not have antlers since they are shed earlier in the year.

Cautionary note
While the authors believe that the advice given here offers their best understanding on how to approach antler problems in deer, colleagues following these guidelines should alert owners to the potential risks and uncertainties involved and do so at their own risk. Serious consideration should be given to the advisability of keeping reindeer in mild temperate regions, not only because of the possible problems associated with antler hypertrophy in castrates but also because these are sub-Arctic species that are prone to a number of diseases that they may not encounter in their native regions. As a general caveat, the authors consider that reindeer are, in general, ill-suited to being enclosed in small paddocks, especially in the south of England. The Animal and Plant Health Agency (APHA) has produced further information regarding reindeer (APHA 2014).

The Veterinary Deer Society would be interested to hear from colleagues who have been involved in dealing with antlers of red deer and reindeer in these situations so that a collective view of effective practices can be built up.

Acknowledgements
The authors thank Nick Crabb for preparing Fig 1 and Tracy Dewey for her help with Fig 4.

References
Bubenik, G. A., Schams, D., White, R. J., Rowell, J., Blake, J. & Bartos, L. (1997) Seasonal levels of reproductive hormones and their relationship to the antler cycle of male and female reindeer [Rangifer tarandus]. Comparative Biochemistry and


Further reading


Further information

Information about the Veterinary Deer Society may be found at www.vetdeersociety.com.

Quiz: Managing antler problems in deer

1. Which species of British deer do not grow antlers?
   a. Red deer
   b. Fallow deer
   c. Roe deer
   d. Chinese water deer

2. Which species of British deer grow antlers in winter?
   a. Red deer
   b. Fallow deer
   c. Roe deer
   d. Muntjac

3. Red deer usually shed their antlers in which month?
   a. December
   b. February
   c. May
   d. July

4. Male Reindeer usually shed their antlers in which month?
   a. January

b. July
c. September
d. December

5. What is the name for the disorganised antler growth that is commonly seen in castrated roe deer?
   a. Velvet
   b. Huemul
   c. Perrueque
   d. Antleroma

6. What important recommendation should be made to those bottle rearing male red deer calves?
   a. Never keep male and female calves together
   b. Castrate them to help prevent aggressive behavioural problems as adults
   c. Wait until they are mature before castration to allow normal behavioural patterns to develop
   d. Disbudding calves will prevent development of all male secondary sex characteristics

Answers: D, C, A, B, C, A