DEFLIGHTING PROCEDURES AND THEIR WELFARE IMPLICATIONS IN CAPTIVE BIRDS

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Deflighting is used to prevent large captive birds from escaping by limiting their ability to fly. This practice deprives birds of this normal behaviour, but can allow them to express other behaviours that would be suppressed if they were confined to cages or aviaries. The potential negative welfare issues associated with deflighting include the stress of capture and restraint, pain and discomfort associated with the procedure and during recovery, risk of post-operative infections, risk of neuroma formation which could lead to pain, and loss of the ability to fly. The potential practical and welfare advantages of deflighting include a reduction in the need to closely confine or cage birds to prevent them from escaping, and deflighting may be the only way of keeping particular birds in an open situation for display, such as in parks or zoos. In these respects, there must be a balance between the requirement for this practice and the welfare compromises it introduces for birds. By outlining temporary and permanent methods and the complications involved, the following review highlights potential welfare problems and discusses ways of avoiding them. It also evaluates the necessity of deflighting and the need for careful risk assessment.

Keywords: *animal welfare, deflighting, feather clipping, patagiectomy, pinioning, tenonectomy*

Introduction

Wildfowl in zoological societies, private collections and research facilities are often rendered flightless to prevent their escape. Birds kept as caged pets and within the poultry industry are also subjected to deflighting for control. This practice appears to be becoming less widespread because of changing attitudes; however, in a number of situations, deflighting is preferable to caging if it provides the bird(s) with the opportunity to perform those behaviours that cannot be fulfilled in a conventional cage.

Deflighting typically involves interference with one wing to create an asymmetry that will unbalance the bird when it attempts to fly. Temporary flight restriction is the usual method in aviculture and has occasionally been used in the poultry industry — for instance, to reduce the activity of aggressive cocks during breeding (McLelland 1991). Permanent methods have been applied in the poultry industry in the past (Marsden 1971) to make birds easier to catch

and manage, but generally such methods are only practised on captive wildfowl not intended for release and on uncaged exotic species kept by zoological gardens.

Four of the five freedoms are at risk when deflighting birds: freedom from discomfort; freedom from pain, injury and disease; freedom to express natural behaviours; and freedom from fear and distress (UK Farm Animal Welfare Council 1992). In this paper, the primary aim is to describe deflighting practices and their complications, so that when it is decided that the procedure is justified, the information can help the operator to manage the situation correctly. The justification for the procedure will depend upon the importance of keeping the particular birds in the given situation, and that need will be influenced by local circumstances and cultural traditions.

Handling and restraint

Restraint techniques vary according to the size and temperament of the bird and its means of defence; handlers should be familiar with the risks associated with these techniques. The aim of correct handling procedures is to minimise the overall distress caused to the bird. The correct restraint of poultry is outlined in the New Zealand Code of Recommendations (1996) and Australian welfare legislation, and addresses the special handling needs of different species (SCR Report Series #40 1995). Appropriate methods of restraint for other birds, including waterfowl, pigeons and raptors, obviously vary according to species and are discussed in detail by Fowler (1995), Beynon *et al* (1996) and Olsen (1997).

Panic should be avoided in all species and handlers should be experienced to minimise injury to the birds. Prolonged chasing or exertion in temperatures greater than 27°C can induce hyperthermia, which has been linked to exertional myopathy and even sudden death (Fowler 1995). Birds defend themselves with their beak, wings and feet; precautionary measures such as the use of heavy gloves or placing of a ball of bandage on the tip of the beak may be necessary to avoid injury to handlers. It is important to keep a firm grip on the bird to prevent it from damaging itself in an effort to break free. The wings should be held at the bird's sides to prevent damage to the bird and its handlers. It is well known that, once restrained, handling diurnal birds under subdued lighting or using a hood to cover the eyes often helps to placate them (Fowler 1995; Lawton 1996).

Extra caution should be exercised when handling birds because of the fragile nature of their bones, particularly in species with fine legs (Schultz 1976; Forbes & Richardson 1996; Humphreys 1996). The tibiotarsus–tarsometatarsal joints are prone to sprain or fracture, so legs should be grasped proximal to this site. Domestic fowl should be carried by both legs, taking care that flapping wings do not hit solid objects (NZ Code of Recommendations 1996).

Pressure around the body and especially over the sternum should be gentle but firm so as not to compromise the bird's breathing. There is little danger of suffocating a bird provided it is grasped by the back of the neck. Australian welfare codes recommend catching ducks and geese by the neck, and prohibit catching or carrying these species by the legs (SCR Report Series #40 1995). For heavy-bodied waterfowl, the base of the wings should be grasped in one hand and the other used to support the body (Olsen 1997).

Young birds to be deflighted are held gently, and the wing for treatment is extended and held at the carpal joint between forefinger and thumb (Ward & Batt 1973). An assistant is required to secure larger birds by firmly restraining them on their backs with both wings held closely to the body and the eyes covered. One wing is extended and pinned down manually by the assistant. Care must be taken to prevent flapping, which may fracture the bird's

susceptible ulna (Hediger 1964), and struggling, which can damage the brachial plexus or joints (Fletcher & Miller 1980).

Temporary methods

Feather clipping

This relatively simple technique, also referred to as 'wing clipping', typically involves unilateral cutting of the primary (flight) feathers. Feather clipping is used to control temporary flightiness in caged pets and, when necessary, in poultry. It is best performed by two people, one to hold the bird securely and position the wing, the other to perform the clipping. Firm but gentle restraint prevents injury to the bird if it struggles during the procedure. The wing is extended and scissors are used to cut the primaries below the level of the primary coverts. The three most distal primaries should be left unclipped, to protect and support the fragile new feathers that grow back after a moult (Forbes & Glendell 1999). Allowing the distal primaries to remain also provides a more aesthetic appearance. Care should be taken not to cut the secondaries, which show when the wing is closed. Because feathers will grow back following the next moult, repeated treatment is necessary.

It is important to use sharp instruments, as blunt scissors may splinter the calamus or tear the follicle, which could subsequently irritate the bird. Such irritation may initiate feather-plucking behaviour. When clipping larger birds, tin snips are advisable (Coles 1988). Cutting the wing feathers too short may sever blood vessels, but if the trimmed feathers are left too long, limited flight may be possible. If the cut feathers extend beyond the covert feathers, this can also result in feather plucking — either because the sharp ends cause irritation when the wing is closed against the body, or possibly because the feather stumps appear untidy to the bird (Forbes & Glendell 1999). For waterfowl, feathers should be clipped at the level of the rachis rather than the calamus, to reduce the chance of water entering the hollow feather shaft and causing algal growth or folliculitis (Olsen 1997).

Feather clipping should not be performed when feathers are in the growth or 'blood-quill' stage, as developing feathers are highly vascular. The attached calamus contains dermal tissue and blood vessels that branch from the axial artery and vein. Haemorrhage from loops of these vessels may occur if developing feathers are severed or torn. As the feather matures, the calamus resorbs its blood vessels, becoming hollow (apart from its follicle-embedded tip) and clear in appearance (Fowler 1995).

Feather clipping of one wing effectively prevents flight by unbalancing the bird, which can result in injuries, particularly if it is performed before a young bird learns to fly (Forbes & Glendell 1999). For this reason, it has been suggested that a bilateral clip may be more suitable for birds kept as caged pets. This will allow them to flutter safely from a perch, while still limiting, although not preventing, their ability to fly away (Forbes & Glendell 1999).

Brailing

Strapping the wing in its flexed position is sometimes used by breeders to temporarily restrain young birds, while retaining their full value for sale (Allen 1975). A limitation of this method is that the strap cannot remain in place for longer than three weeks, as it can interfere with normal wing growth (Archarjyo & Ojha 1972).

Permanent methods

All methods of permanent deflighting of adult birds should be performed under general anaesthesia by a trained veterinarian. Inhalation anaesthesia is the preferred method and isofluorane the preferred avian inhalation agent (Lawton 1996; Heard 1997). Injectable agents can also be used but they are less safe and recovery is usually more prolonged and traumatic. Analgesia should also be provided for any surgical procedures in adult birds. Injectable opioid analgesics, such as butorphanol or buprenorphine, can be used intra-operatively and post-operatively (Bauck 1990).

Radial neurectomy

Radial neurectomy is the surgical removal of about 8–10 mm of the radial nerve supplying the wing. In the 1940s it was put forward as a permanent method of deflighting, but has since been discounted after practical attempts at the technique showed that it was completely ineffective at preventing flight (Hediger 1964).

Pinioning

As with feather clipping, pinioning of adult birds should not be carried out when the primaries are in the growth stage. Adult pinioning can take place any time prior to moulting or well after a moult, allowing time for the calamus to resorb its vascular components. Some methods involve surgical removal of the distal wing portion including the ulnar carpal bone (Wallach 1987), or exarticulation and severing of all the wing attachments at the carpo-metacarpal joint (Acharjyo & Ojha 1972). Most commonly, the amputation site is at the metacarpals below the alula or 'bastard wing' (Figure 1).

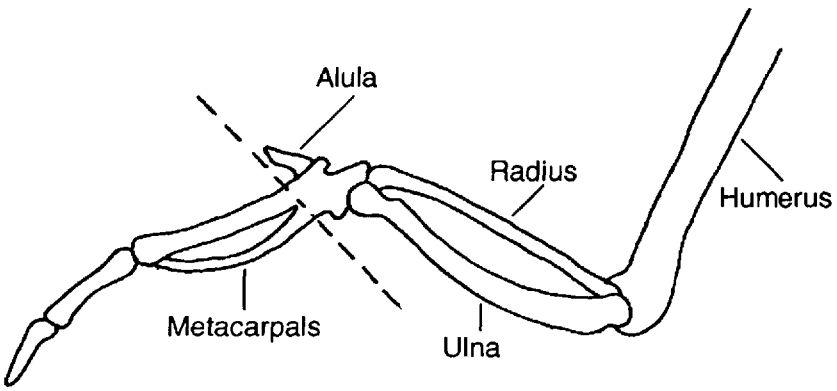

Figure 1 **Pinioning closely below the alula allows it to remain as protection for the stump (dashed line indicates plane of amputation).**

When pinioning is considered to be necessary, this should ideally be performed on chicks 2–3 days after hatching (Forbes 1996; Humphreys 1996), before the supporting bone hardens and at a stage when haemorrhage is minimal (Ward & Batt 1973). Haematostatic clips have been used to successfully pinion young birds of a number of species including geese, swans and flamingos (Robinson & Buzikowski 1975). A haematostatic clip is positioned transversely on the metacarpal immediately distal to the alula and sharp scissors are used to snip off the remaining wing tip. Healing takes 8–10 days, and the clip falls off of its own accord. In downy young birds (less than one week old), this operation may be performed

simply with scissors instead of with haematostatic clips because of the minimal blood loss at this age (Ward & Batt 1973; Humphreys 1996; Olsen 1997). The alula spur should remain to protect the stub from reinjury later in life (Hayes 1981).

When pinioning adult birds, care should be taken in plucking the wing area to minimise skin trauma and capillary bleeding. Venous circulation may be occluded by ligature of the large ulnar vein (Wallach 1987) or by use of a tourniquet positioned at the mid-humerus to occlude circulation to the site via the deep brachial veins and the subcutaneous basilic vein, the wing's main venous trunks (Fletcher & Miller 1980; Humphreys 1996). Alternatively, a tourniquet can be placed in the carpal area, behind the alula (Coles 1985). Amputation may be performed using a surgical saw (Ward & Batt 1973), strong bone shears (Hayes 1981; Coles 1985), an emasculator or bone forceps (Fletcher & Miller 1980; Coles 1985).

Whatever instrument is used, sterility and speed are essential, and during the procedure care must be taken not to damage surrounding tissues (Fletcher & Miller 1980). Cutting and stripping back the skin and muscle distal to the amputation site allows the tissues to be pulled over the severed ends of the bone (Ward & Batt 1973; Fletcher & Miller 1980; Coles 1985; Humphreys 1996; Olsen 1997). Allowing sufficient skin to remain to cover the bone is also important in order to prevent pressure necrosis (Olsen 1997). Although this technique is undoubtedly more time-consuming, post-operative benefits include reduced reinjury and infection. When suturing the wound, correct tensioning will preserve skin-flap circulation and help prevent avascular necrosis (Fletcher & Miller 1980).

Although suturing is standard procedure following pinioning of adult birds (Ward & Batt 1973; Fletcher & Miller 1980; Wallach 1987; Humphreys 1996; Olsen 1997), Acharjyo and Ojha (1972) successfully pinioned numerous birds without suturing, and Allen (1975) merely left the constricting ligament in place following surgery. Pinioning may not require suturing, but it should be considered for larger birds, particularly where cauterisation is not used. Furthermore, suturing may also serve to reduce post-operative infections (Fletcher & Miller 1980).

Following amputation, the tourniquet should remain in place for a duration sufficient to ensure adequate haemostasis. Often the wound is not cauterised, but Hayes (1981) and Wallach (1987) recommend this precaution. Haemostatic agents can be applied after amputation to further minimise haemorrhage risk; these are addressed in more detail later. If an emasculator is used for amputation, the blood vessels will be crushed providing adequate haemostasis and the wound can be left to heal by granulation (Fletcher & Miller 1980). The operator should inspect the wound for bone splintering prior to administration of a broad-spectrum antibiotic, which may be placed subcutaneously at the stump's end prior to dressing (Wallach 1987).

Haemostasis when pinioning larger birds can be performed by introducing an absorbable double ligature between the interosseus space of the metacarpals. This technique has been successfully used for control of haemorrhage in a variety of species including pelicans, swans, flamingos and vultures (Fletcher & Miller 1980; Humphreys 1996; Olsen 1997). Figure 2 shows the anatomical relationship of the skeletal and vascular structures in the distal part of the right wing. The ventral metacarpal artery courses along the inner surface of the fourth metacarpal bone, providing an ideal site for vessel ligation.

Care must be taken when inserting the needle to prevent laceration of the ventral metacarpal artery or its branches, or penetration of the venous circulation. The initial suture traps the artery between the suture and the inner edge of the fourth metacarpal and acts as the main control against arterial haemorrhage. A second proximal suture surrounds both

metacarpals under the alula, preventing venous haemorrhage. The amputation is performed distal to the sutures and pre-cut skin flaps are sewn in place over the stump (Fletcher & Miller 1980; Humphreys 1996; Olsen 1997).

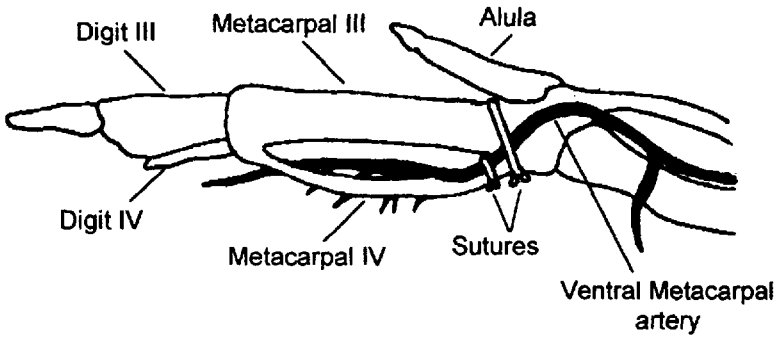

Figure 2 **Pinioning technique for large birds involving ligature of the ventral metacarpal artery to control haemorrhage. Amputation is performed across the metacarpals, distal to the sutures.**

Pinioning of pelicans is a special case as they have an unusual feature of their respiratory system: an interclavicular air sac branches through the wing bones to the metacarpals. Fletcher and Miller (1980) describe suturing skin flaps over the stump as a necessary precaution against aspiration of water into the pelican's lower respiratory tract. The pinioning technique applied by Acharjyo and Ojha (1972) to Rosy pelicans did not involve any of the prudent measures taken by Fletcher and Miller (1980). Following the operation, Acharjyo and Ojha (1972) did note a period of inappetance in these birds that they had not observed in other species; however, no complications were reported.

Patagiectomy

This method is used in large birds such as storks and cranes that have a lower body weight in relation to wing span because, even when pinioned, aided by gusts these species may escape from an enclosure with a low perimeter (Robinson 1975; Fletcher & Miller 1980). The patagial membrane, or propatagium, is the triangular fold of skin that extends between the shoulder and carpal joints; the propatagial ligament extends along its leading edge. After unilateral removal of a portion of the propatagium, full extension of the wing becomes impossible (Figure 3). The membrane is first cut from the attachment near the carpal joint to the radius–humeral joint, care being taken to avoid damaging the adjacent muscles and blood vessels; this is then repeated along the humeral margin. The triangular portion is excised and the radius and humerus juxtaposed with wire sutures prior to suturing the cut edges of the skin together (Robinson 1975).

Tenonectomy

Tenonectomy of the main wing tendon, or extensor carpi radialis, also prevents extension of the wing. This technique, sometimes referred to as 'notching' or 'dewinging', was formerly practised in the poultry industry and involved immobilising the wing tendon that runs over the carpal joint. Tenonectomy was performed primarily on chicks by cutting (Marsden 1971)

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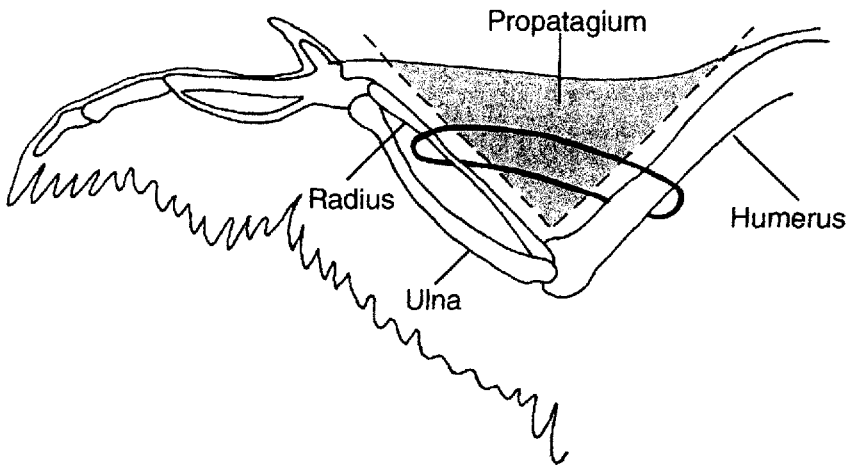

Figure 3 **Patagiectomy involves removing most of the propatagium (shaded area) to prevent extension of the wing. The humerus and radius are juxtaposed with wire sutures.**

or by cutting and cauterisation of the main wing tendon. In the literature, there do not appear to be reports of any particular problems associated with this technique. Performing tenonectomy in chicks is relatively simple and seems to avoid many of the complications that can develop when surgically deflighting older birds. Distress following the procedure may also be minimal, because of the speed of the surgery and because less tissue damage is incurred.

In adult birds, tenonectomy is performed under general anaesthesia. A longitudinal incision is made over the carpal joint and the tendon of the extensor metacarpi radialis is exposed. A small segment (1–2 cm) is removed. The joint is then exposed and cauterised to disrupt the articular surface. Ultrasound dental scalers or curettes can also be used. The joint is then immobilised in the normal flexed position for up to three weeks until it is ankylosed. If the bandage is removed too early the distal wing tip may droop (Boardman 1994).

More recently, a different method of tenonectomy has been developed that involves removal of a section of the insertion of the superficial pectoral muscle and propatagial tendon (Fletcher 1989). This procedure disrupts the down-stroke of the wing and hence reduces flight speed, but otherwise allows the wing to function normally. Because of the anatomical location of the site targeted for surgery, this alternative form of tenonectomy, detailed in Olsen (1997), is considerably more involved than tenonectomy of the extensor metacarpi radialis. A major advantage of this newer technique is its aesthetic appeal as the skeleton of the bird remains intact (Fletcher 1989; Olsen 1997); because of its effect on skeletal muscle, however, this method is likely to be more painful.

Carpal wiring

Wiring of the carpal bones has been referred to by Coles (1985) as an alternative deflighting technique, but no further literature regarding this practice was apparent.

Complications

Haemorrhage

Wallach (1987) cautioned that "haemostasis is, undoubtedly, one of the most important facets of avian surgery". Whichever method is used, some thought will need to be given to ways of controlling bleeding. Even simple techniques such as feather clipping may result in excessive bleeding if performed during the feather's growth period, or if feathers are torn through use of blunt scissors. In comparison with mammals, birds' skin is delicate (McLelland 1991), and its loose attachment to underlying muscle can result in extensive bleeding beneath the skin when trauma occurs. Continued post-operative bleeding can compromise recovery and make the procedure unsightly, as well as provoke unwanted inquisitive behaviour from pen-mates.

Birds have a higher systemic blood pressure than mammals and, in general, blood loss occurs more quickly (Coles 1985). Although in larger birds death from haemorrhage is unlikely (Bigland 1964), smaller birds can be severely compromised or even die as a result of uncontrolled bleeding (Coles 1985; Wallach 1987). Capillary bleeding is easily stemmed by compression or by use of an astringent haemostatic agent (commercial powders/foam, silver nitrate). Alternative haemostatics include topical application of a vasoconstrictor (eg adrenaline) or use of absorbent materials or pharmaceutical solutions that act as a network for clot formation (Upson 1985; Bishop 1996). The potential for haemorrhage associated with deflighting varies according to the age of the bird and the type of procedure performed.

Pinioning of chicks before the wing's supporting tissues have hardened reduces risks associated with haemorrhage and is generally preferred to operating on adult birds. As mentioned previously, when the amputation is performed on chicks this usually results in only minor blood spotting at the stump, which is easily controlled by the use of haemostatics or through radiosurgery (Olsen 1997).

For adult birds, while clamping and careful ligature are commonly practised during pinioning, electrocautery has been suggested for haemorrhagic control of larger vessels (Fletcher & Miller 1980). Kear and Duplaix-Hall (1975) routinely used an electric debeaker for simultaneous cauterisation when pinioning adult flamingos, which would have helped to control bleeding.

To minimise blood loss, pinioning should not be carried out in hot weather. Blood supply to the wing is extensive, with the brachialis artery and vein branching distally toward the metatarsal region. An advantage of patagiectomy is that disruption of these major blood vessels is avoided (Robinson 1975).

Infection

Adequate preparation of the site, the use of sterile instruments and the application of antibiotics should prevent the occurrence of post-operative complications resulting from infection. It has been claimed that careful removal of feathers from the wing site prior to operating not only prevents capillary bleeding but also reduces the route for post-surgical infections (Wallach 1987). After pinioning water birds, Fletcher and Miller (1980) recommend suturing skin flaps over the stump and coating the site with a waterproof ointment to protect birds against ascending osteomyelitis from secondary infection.

Olsen (1997) notes further that for waterfowl, it is important to prevent access to the pool for 3–7 days after pinioning to reduce contamination of the incision. Alternatively, sealing the wound with tissue glue (Olsen 1997) or a commercial spray (Humphreys 1996) may protect the site sufficiently to allow the bird to be immediately returned to the pool (Olsen

1997). For water birds, another important factor in reducing contamination of surgical wounds is to ensure that the water in their enclosure is of good quality (Humphreys 1996).

The bird's housing arrangement should be assessed to minimise causal agents of infection, and knowledge of the species' susceptibility to particular infections can help to prevent post-operative complications (Coles 1988). If amenable to handling, the bird should be inspected 24 h after the operation and assessed for any signs of infection such as discharge from the site. In addition to minimising blood loss, a further reason for avoiding pinioning during the warmer months is that fewer flies will be attracted to the site.

Neuroma

Following surgery, amputation neuromas develop during regeneration of the proximal stump of the transected or disrupted nerve. When the regenerating axonal components within the stump seek to repair nerve integrity, they encounter scar tissue formed by fibroblast proliferation and are forced to divert, often dividing and branching many times. A neuroma is the resulting disorganised tangle of regenerating axons (neurites), Schwann cells and connective tissue (Sunderland 1968; Kline 1987). Amputation sites at which neuromas have developed can be highly sensitive (Sunderland 1968). On account of this, it may be advisable to consider protecting the stump from physical insults.

The presence of neuromas and spontaneous electrical afferent activity in stumps has been examined when assessing the welfare of poultry following beak trimming (Breward & Gentle 1985; Gentle & Hunter 1988). Neuromas are likely to develop following partial wing amputation, but there is no evidence to confirm this; therefore, the length of time for which traumatic neuroma may persist, or the presence or extent of chronic pain associated with their formation, is unknown.

Reinjury

Injuries can occur when deflighted birds make unsuccessful attempts at flying; most commonly this results in damage to their sternum, head or limbs (Forbes & Glendell 1999). Roosting species may take time to adjust to the handicap, but some species can compensate by using the beak to assist in climbing (Coles 1988). Feather clipping can result in feather plucking and self-mutilation behaviour in birds (Coles 1988; Forbes & Glendell 1999). As previously mentioned, cutting feathers to the correct length and the use of sharp scissors that will not splinter or pull at the feathers should prevent subsequent worrying behaviour.

Post-operative mechanical stimulation of this site is likely to elicit a painful response in the wing stump; therefore, when pinioning, it is important to allow the alula to remain as protection. Also, reinjury is reported to be less likely to occur in birds pinioned at the metatarsals than those in which the wing has been disarticulated at the carpal joint (Acharjyo & Ojha 1972). To protect the remaining stump, Hayes (1981) recommended that the plane of amputation be angled parallel to the humerus and as close under the alula as possible. In addition, suturing the alula and its feathers over the amputated stump may help to prevent secondary trauma (Fletcher & Miller 1980). Ensuring that a protective pad of tissue remains can further help in preventing post-operative wound breakdown (Coles 1988; Olsen 1997).

Following the amputation, birds may attempt to dislodge sutures or a remaining ligature. Sutures that are secured around bone are less likely to be removed during preening (Fletcher & Miller 1980). An Elizabethan collar may be necessary for birds that are ardent suture pickers.

Post-operative care

Anticipating the physical and mental requirements of the bird following an operation serves to reduce post-operative complications such as shock, infection and reinjury. The goals of post-operative care are to minimise suffering and to provide a suitable environment for rapid recuperation. Basic post-operative considerations should include providing the bird with a quiet, warm and secure area to assist in recovery.

Views on the level of care that should be extended during and after an operation are often subjective and based on personal or society's perception of an animal's welfare. Allen (1975) outlined the "most widely accepted technique" for permanently deflighting pheasants in the 1970s, which involved use of a nylon fishing line or cord ligature that was tied around the stump, trimmed, and left to slough off following amputation. Society's perception of what is acceptable will vary with time, and this particular technique has now lost some of its former 'acceptability'.

Most operators cited in this paper provided an antibiotic of some form following surgical deflighting and protected the stump of older birds by bandaging. For smaller birds, the wing may simply be bandaged to the body (Coles 1988). To minimise distress from social isolation, the bird is usually released into the company of other flock members following surgery. This enhances recuperation and provides for the bird's psychological welfare. Although inspection of the wound 24 h after the operation is recommended by Hayes (1981), some authors advise against disturbing the birds for several days or handling them prior to healing of the wound (Ward & Batt 1973).

Shock is more likely to develop in wild birds and can seriously compromise their health. Competent handling and minimisation of blood loss during surgery are the major factors in helping to prevent shock. Symptoms can develop anywhere between 15 min and 6 h after a restraint episode, and handlers and keepers should be alert for any signs. Capture shock alters the metabolic processes of the bird and although the only visible signs may be shallow, rapid breathing and depression, hyperthermia, tachycardia and subsequently hypotension can also occur. In severe cases, capture shock may culminate in circulatory collapse and death (Fowler 1995).

It has been reported that soon after pinioning, a number of smaller duck species repeatedly attempt flight when alarmed (Hediger 1964). In this case, the additional caution of confining the birds in an aviary and minimising disturbance until the wounds heal should be considered to help prevent reinjury.

Behavioural considerations

Pain recognition

Suffering in animals is often quantified using behavioural observations. Gentle *et al* (1990) successfully used behavioural indices to quantify chickens' welfare following partial beak amputation. Their study provided evidence for persistent pain associated with this procedure. Behavioural effects following deflighting have not, however, been reported in the literature.

Recognising pain in birds is an important feature in determining whether an individual's welfare is compromised. Sanford *et al* (1986) describe a bird in pain as showing escape reactions with vocalisation and excessive movements. When handled, birds may instead exhibit tonic immobility rather than struggling, but during physical examination may present with increased respiratory and heart rate (Coles 1985; Gentle 1992; Sanford *et al* 1986). Gentle (1992) describes these responses to noxious stimuli as "flight–fight" and "conservation–withdrawal" behaviours, the elicitation of which is dependent upon the type of

nociceptor that has been activated. Inappetance and inactivity are indicative of chronic pain; the appearance of the bird may also suffer, becoming 'droopy' and dishevelled. Similar ethological indicators of clinical pain responses have been described by Fraser and Quine (1989).

Behavioural deprivation

Deflighting of birds has highly controversial welfare implications. The loss of flight restricts a range of behaviours including the ability to escape, roost, or migrate, and may also be viewed somewhat subjectively as depriving the bird from the 'satisfaction' of flight. In these respects, deflighting of birds could be seen to directly compromise their freedom to express normal behaviour. Paradoxically, deflighting is actually used to allow birds to perform other normal behaviours. For example, the permanent deflighting methods applied to wildfowl in zoological gardens allow large birds to be kept in the open, which must give them more freedom to express natural behaviours such as foraging and exploring than conditions within the confines of an aviary.

Deflighting techniques are more commonly applied to some types of birds than others — for example, restriction of waterfowl is much more common than restriction of raptors. This discrepancy is likely to reflect not only the birds' adaptation to alternative forms of locomotion (ie walking, swimming or climbing), but our own perception of the relative 'importance' of flight to particular species.

There are few reports of deflighting leading to any apparent chronic suffering in birds. It is difficult to conclude in an objective manner whether the inability to express this natural behaviour presents severe welfare compromises for birds, because there is little evidence to indicate the extent of psychological suffering imposed by such a restriction.

Are the techniques necessary?

The two reasons birds are subjected to deflighting are to prevent escape and for control. From an economic point of view, deflighting of birds prevents the loss of priceless exotic species from zoological gardens and wildlife parks. This husbandry practice can also aid in wildfowl recovery and assist in restraint of research facility flocks. Deflighting can offer advantages to captive birds kept in certain situations by increasing their freedom and by allowing them to express other natural behaviours such as foraging.

Procedures that render a bird permanently flightless have raised important welfare concerns. Justification for deflighting should be assessed on a case-by-case basis, and most commonly it is restricted to large and medium sized birds that will be housed in zoological displays, open paddocks or topless pens. Changing attitudes regarding the permanent deflighting of birds are apparent, and are reflected in an increasing preference for the use of alternative husbandry practices. These include the use of a knotless nylon mesh to enclose pens (Forbes & Richardson 1996) and the growing popularity of large free-flight aviaries within the zoo industry.

One distinct advantage that permanent deflighting offers over temporary methods is that repeated treatment is avoided. Given the potential welfare complications involved in capture and restraint of birds, and particularly the handling of wild birds, permanent deflighting methods may actually represent a more humane option in some cases. In addition, for facilities with large numbers of birds, repeated capture and treatment of individuals may not be feasible because of economic and time-management constraints.

Birds kept as pets that are let out of their cages can be successfully feather clipped to restrict, rather than disable, flight. Parrot owners should, however, be encouraged to use basic obedience training to assist in control, rather than resorting to deflighting techniques (Forbes & Glendell 1999). If owners wish to take their unrestrained parrot outside, it can be placed within an aviary to prevent escape (Forbes & Glendell 1999). Species kept in an aviary and smaller caged birds should also not require a permanent flight handicap with the exception of those prone to repeated injurious 'flighty' behaviour. Bird keepers should ask themselves whether it is fair to keep species prone to flighty behaviour in close confinement, irrespective of whether or not they are deflighted.

Legislation

In some countries, surgical manipulation of the wings with the aim of impeding flight in farmed birds is limited to particular circumstances. For example, in the United Kingdom, the Welfare of Livestock Code (1987) disallows pinioning for poultry situated on agricultural land except by a veterinary surgeon in an emergency or when disease or injury is present and proper treatment requires the operation. Feather clipping is permitted as a routine procedure, but is not commonly used in farmed birds.

Despite the more widespread application of deflighting techniques for birds maintained in private and zoological collections, legislative regulations concerning these practices appear to be limited. In Britain, however, pinioning of all adult birds is legally restricted to veterinary surgeons (Humphreys 1996).

Recommendations

Practical guidelines and a specific code of welfare for species subjected to deflighting procedures are needed. They should focus on who may conduct the procedures, which technique to use, the way in which the procedure is carried out and the level of post-operative care required to meet the birds' welfare needs.

Determining who can conduct deflighting techniques depends on the methodology and the complexity of the operation. In some situations, a simple method that does not involve surgery (eg feather clipping) can be readily performed by lay persons following some basic guidance. It would therefore be unnecessary to limit all deflighting techniques to veterinarians.

The technique to be used should depend largely on the captive environment and the housing arrangements. Temporary methods are generally sufficient for birds kept as pets and, when deemed necessary, provide an appropriate level of restraint for birds kept as livestock. Permanent deflighting techniques are becoming restricted to aviculture and zoological establishments, and in some circumstances may be more desirable, as they do not involve repeated capture and restraint. During an assessment, the species in question also needs to be considered with regard to the level of flight restraint that is necessary and the use of an appropriate technique. In large collections of wildfowl and particularly within the poultry industry, when deflighting techniques are deemed necessary, constraints set by economic viability may also mean that a technique has to be assessed in terms of its efficiency and cost.

Whichever method is decided upon, areas of potential welfare compromise need to be recognised. These include fear and distress, pain, injury and disease. Minimising distress by competent handling is important to help prevent injury and reduce shock associated with the procedure. Even non-surgical techniques such as feather clipping may cause undue suffering

if performed incorrectly. Permanent deflighting of adult birds should always be performed under general anaesthesia. The use of appropriate instruments and aseptic techniques will minimise risk of haemorrhage and post-operative infection. Post-operative care should include protection of the site, provision of analgesia to reduce associated pain, and housing of the bird in a suitable area during recovery.

Summary

This review describes temporary and permanent deflighting procedures used in captive birds, and the complications associated with the use of these techniques. From a welfare perspective and where these operations are deemed to be necessary, the appropriate method needs to be selected and evaluated on a case-by-case basis. Risk management deserves recognition when assessing each procedure, and could serve to improve conditions for birds within industry and aviculture.

Codes of practice have provided a backstop for unnecessary industrial techniques in poultry husbandry and appear to be more thorough in their approach than the guidelines for captive wild species. Research into amputative procedures in mammals has been more central to welfare concerns, although captive birds also routinely undergo similar practices. Clearly, a greater focus on avian welfare is justified.

Deflighting has serious ethical implications, perhaps instilling a more anthropomorphic empathy in society than other routine mutilation practices. Deflighting is, however, a practice that delivers benefits to the captive bird by, ironically, increasing its freedom within captivity. There is little evidence one way or the other to allow us to conclude whether deflighting procedures unduly compromise the welfare of the bird. This predicament is a familiar dilemma to certain areas of animal welfare. Evaluating the necessity of these techniques in captive birds will help to create a more standardised level of welfare for non-mammalian species.

Animal welfare implications

Deflighting procedures are routinely performed on captive birds for a variety of reasons, but the overall welfare aim should be the same: limitation of the practice to particular circumstances and the use of a suitable technique that minimises complication and distress to the bird. Areas of potential welfare compromise associated with this husbandry practice include physical, behavioural and psychological suffering. When justified, assessment of the appropriate method, the level of skill required by the operator, and the way in which precautionary measures should be taken to prevent compromising the birds' welfare need to be carefully considered. Nonetheless, deflighting may be an essential husbandry practice for some domestic and wild birds, and can offer improved welfare by increasing their level of freedom within captivity.

References

Acharjyo L N and Ojha S C 1972 Pinioning of wild birds in captivity — a clinical study. *Indian Veterinary Journal 49*: 718-725

Allen G A Jr 1975 *Ornamental Pheasants* pp 45-46. American Gamebird Breeders Co-operative Federation: Utah, USA

Bauck L 1990 Analgesics in avian medicine. Proceedings of the Annual Conference of the Association of Avian Veterinarians. *Zoological Record 127* (Section 18 — Aves): 239-244. BIOSIS: London, UK

Beynon P H, Forbes N A and Harcourt-Brown N A 1996 *Manual of Raptors, Pigeons and Waterfowl.* BSAVA Ltd: Cheltenham, Gloucester, UK

Bigland C H 1964 Blood clotting times of five avian species. *Poultry Science 43*: 1035-1039

Bishop Y 1996 (ed) *The Veterinary Formulary Handbook of Medicines Used in Veterinary Practice, Edn 3.* London Royal Pharmaceutical Society of Great Britain: London, UK

Boardman W S J 1994 Deflighting birds. *Kokako 3*: 2(1) pp 4-5

Breward J and Gentle M J 1985 Neuroma formation and abnormal afferent nerve discharges after partial beak amputation (beak trimming) in poultry. *Experientia 41*: 1132-1136

Coles B H 1995 *Avian Medicine and Surgery.* Chandler E A (ed). Blackwell Scientific Publications: Oxford, UK

Coles B H 1988 *Manual of Parrots, Budgerigars and Psittacine Birds* pp 64-65. Price C J (ed). BSAVA Ltd: Cheltenham, Gloucester, UK

Fletcher K C 1989 Surgical deflighting of cranes without altering the normal osteology of the wing. *Proceedings of the 44th Annual Conference of the International Union of Directors of Zoological Gardens* pp 118-119. National Zoological Park Library: Smithsonian Institution, Washington, USA

Fletcher K C and Miller B W 1980 A technique for cosmetic pinioning of adult birds. *Veterinary Medicine and the Small Animal Clinician 75*: 1898-1904

Forbes N A 1996 Neonatal diseases. In: Beynon P H, Forbes N A and Harcourt-Brown N A (eds) *Manual of Raptors, Pigeons and Waterfowl* pp 330-333. BSAVA Ltd: Cheltenham, Gloucester, UK

Forbes N A and Richardson T 1996 Husbandry and nutrition. In: Beynon P H, Forbes N A and Harcourt-Brown N A (eds) *Manual of Raptors, Pigeons and Waterfowl* pp 289-298. BSAVA Ltd: Cheltenham, Gloucester, UK

Forbes N A and Glendell G 1999 Wing clipping in psittacine birds. *Veterinary Record 144*: 299 (letter)

Fowler M E 1995 *Restraint and Handling of Wild and Domestic Animals, Edn 2.* Iowa State University Press: Iowa, USA

Fraser A R and Quine J P 1989 Veterinary examination of suffering as a behaviour-linked condition. *Applied Animal Behaviour Science 23*: 353-364

Gentle M J 1992 Pain in birds. *Animal Welfare 1*: 235-247

Gentle M J and Hunter L H 1988 Neural consequences of partial toe amputation in chickens. *Research in Veterinary Science 45*: 374-376

Gentle M J, Waddington D, Hunter L N and Jones R B 1990 Behavioural evidence for persistent pain following partial beak amputation in chickens. *Applied Animal Behaviour Science 27*: 149-157

Hayes F N 1981 *The Aviculture, Re-establishment and Status of the New Zealand Brown Teal (*Anas aucklandica chlorotis*).* Ducks Unlimited (NZ) Incorporated: Hamilton, NZ

Heard D J 1997 Anaesthesia and analgesia. In: Altman R B, Clubb S L, Dorrestein G M and Quesenberry K (eds) *Avian Medicine and Surgery* pp 807-827. W B Saunders Company: Philadelphia, USA

Hediger H 1964 *Wild Animals in Captivity.* Dover Publications Inc: New York, USA

Humphreys P N 1996 Wing and leg problems. In: Beynon P H, Forbes N A and Harcourt-Brown N A (eds) *Manual of Raptors, Pigeons and Waterfowl* pp 311-314. BSAVA Ltd: Cheltenham, Gloucester, UK

Kear J and Duplaix-Hall N 1975 Pinioning captive flamingos. In: Kear J and Duplaix-Hall N (eds) *Flamingos* pp 220-221. Poyser: Berkhamsted, Hertfordshire, UK

Kline D G 1987 Neuromas of nerve. In: Adelman G (ed) *Encyclopaedia of Neuroscience, Vol 2* pp 808. Birkhauser: Boston, USA

Lawton M P C 1996 Anaesthesia. In: Beynon P H, Forbes N A and Harcourt-Brown N A (eds) *Manual of Raptors, Pigeons and Waterfowl* pp 79-88. BSAVA Ltd: Cheltenham, Gloucester, UK

Marsden S J 1971 *Turkey Production.* Agriculture Handbook No. 393: Agricultural Research Service, United States Department of Agriculture, USA

McLelland J J 1991 *A Color Atlas of Avian Anatomy.* W B Saunders Company: London, UK

New Zealand Code of Recommendations and Minimum Standards for the Welfare of Layer Hens 1996 Draft 7 (March) pp 9-11. MAF: Wellington, NZ

Olsen J H 1997 Anseriformes. In: Ritchie B W, Harrison G J and Harrison L R (eds) *Avian Medicine: Principles and Application* pp 694-719. Wingers Publishing Inc: Florida, USA

Robinson P T 1975 Unilateral patagiectomy: a technique for deflighting large birds. *Veterinary Medicine and the Small Animal Clinician 70*: 143-145

Robinson P T and Buzikowski R B 1975 Pinioning young birds with hemostatic clips. *Veterinary Medicine and the Small Animal Clinician 70*: 1415-1418

Sanford J, Ewbank R, Molony V, Tavenor W D and Uvarov O 1986 Guidelines for the recognition and assessment of pain in animals. *Veterinary Record 118*: 334

Schultz D J 1976 Veterinary management of wild birds. In: Proceedings of Post-Graduate Course for Veterinarians: Fauna. Issue no. 36 pp 107. University of Sydney: Sydney, Australia

SCR Report Series #40 1995 Australian Model Code of Practice for the Welfare of Animals: Domestic Poultry, Edn 2. CSIRO: Melbourne, Australia

Sunderland S 1968 *Nerves and Nerve Injuries*. E & S Livingston Ltd: Edinburgh/London, UK

United Kingdom Welfare of Livestock Code 1987 Prohibited Operations (Amendment) Regulations SI. No. 114. London, UK

Upson D W 1985 *Upson's Handbook of Clinical Veterinary Pharmacology* pp 407-408. Veterinary Medicine Publishing Company: Kansas, USA

Wallach J D 1987 Surgical techniques for cage birds. *Veterinary Clinics of North America 3*: 231-237

Ward P and Batt B D J 1973 Clipping and pinioning. In: Trefethen J B (ed) *Propagation of Captive Wildfowl* pp 60-62. Delta Wildfowl Reserve Station: Utah, USA