WELFARE ASPECTS OF BEAK TRIMMING IN POULTRY

M.J. GENTLE

Summary

This paper reviews current research on the welfare problems associated with beak trimming in poultry. The benefits to the bird are discussed, together with the adverse effects of potential acute and chronic pain, and sensory loss. The causal mechanisms for feather pecking are not understood and at present there is no clear hypothesis to explain the effectiveness of beak trimming in reducing feather pecking and cannibalism. A case can be made for the continuation of beak trimming on welfare as well as production grounds provided it is performed only once in young chicks. In the long term trimming should be phased out and undesirable behaviour controlled by environmental means and genetic selection of commercial stock which do not engage in damaging pecking.

I. INTRODUCTION

Beak trimming, variously called debeaking or partial beak amputation, is a procedure widely used by the poultry industry for reducing the incidence and harmful effects of feather pecking, aggressive pecking and cannibalism. It has been a contentious issue ever since the publication in the UK of the report of the Brambell Committee in 1965, in which it was criticized on two main grounds: that the procedure itself resulted in pain and that it deprived the birds of full use of its 'most versatile member' (Brambell, 1965). Thirty years has now passed since the report was published, and it is generally accepted that we still do not have laying stocks available which can be confidently housed in large flocks on the floor without exposing them to the risk of a major and damaging outbreak of cannibalism. In considering the welfare aspects of beak trimming we need to consider the costs and benefits to the animal rather than the producer, although the prevention of cannibalism benefits both. There are however occasions where difficult decisions have to be made. For example feather pecking can be more easily controlled in cages than in more extensive systems, yet it is argued by many of the animal welfare organizations (UK, Farm Animal Welfare Council, Royal Society for the Prevention of Cruelty to Animals) that the welfare of the birds is better served in extensive systems even though birds have to be beak trimmed. This review presents some of the recent work on the behavioural and physiological consequences of beak trimming.

II. BENEFICIAL EFFECTS FOR THE BIRD

It is clear that reduced mortality rates in beak trimmed birds (Denbow et al., 1984; Lee and Craig, 1991; Struwe et al., 1992; Grigor et al., 1995), reflecting decreased cannibalism, implies less suffering for individual birds. Feather pecking is also reduced and beak trimmed flocks have better plumage (Hughes and Michie, 1982; Grigor et al., 1995). Considerable force is required to remove feathers with values of 400 to 750 g reported for dorsal feathers in White Leghorn hens (Ostmann et al., 1963) and 2 to 4 kg to remove the primary remiges (Lucas and Stettenheim, 1972).

Roslin Institute, Roslin, Midlothian, EH25 9PS U.K.
These forces are considerably in excess of the 2 to 5g required to activate the mechanothermal and high threshold mechanical receptors (nociceptors) which signal noxious stimulation of the skin (Gentle, 1989). In a study where a variety of physiological (ECG, EEG, BP) and behavioural parameters were examined following feather removal there was clear evidence that it is painful (Gentle and Hunter, 1990) and therefore feather pecking constitutes a welfare problem. In addition to reduced feather pecking there are reports of fewer aggressive interactions when group-housed birds are beak trimmed (Eskeland, 1977); the reduced social disturbance is especially obvious at high stocking densities (Eskeland, 1981).

There is evidence that under certain environmental conditions, beak-trimmed birds may be under less stress; e.g. in some studies trimmed laying birds were less fearful than untrimmed ones, both in multi-bird cages and in floor pens (Lee and Craig, 1991), but in other studies there was no effect of beak trimming on fearfulness (Kuo et al., 1991). Furthermore, cage-reared (but not litter-reared) beak-trimmed birds had smaller adrenal glands than controls (Struwe et al., 1992), suggesting less stress.

III. ADVERSE EFFECTS ON THE BIRD

These can be divided into three categories of effects: acute pain, chronic pain and sensory deprivation.

(a) Acute pain

There is no comprehensive definition which would enable the unambiguous determination of whether or not an animal is in pain and there is no reliable universal indicator of pain. What can be done, however, is to compare a range of physiological and behavioural measures with those changes which are associated with pain in humans, and thereby arrive at an estimate of the probability of pain in a given situation. Zimmermann (1986) has proposed a working definition of pain in animals:

"Pain in animals is an aversive sensory experience caused by actual or potential injury that elicits protective motor and vegetative reactions, results in learned avoidance, and may modify species specific behaviour, including social behaviour".

Acute pain lasts for seconds to days and follows nociceptive stimulation or injury and when healing is complete pain is no longer present. A number of studies have shown that the beak of the chicken is well supplied with receptors which are preferentially sensitive to tissue damage, i.e. nociceptors (Roumy and Leitner, 1973; Breward, 1985; Gentle, 1989). In addition to their presence in the beak, nociceptors have also been reported in the buccal cavity (Gentle and Hill, 1987; Gentle, 1979). It would therefore follow that the tissue damage resulting from beak trimming is likely to be acutely painful. Electrophysiological recordings from the sensory nerves in the beak during and immediately after amputation using a heated blade (Gentle, 1991) has shown that the sensory fibres respond just before the blade makes contact with the beak. During amputation and for a period of from 2 to 48 seconds after amputation, there is a massive injury discharge in the sensory fibres which is likely to be responsible for the acute pain produced at the time of amputation.

A recent study of beak trimming in turkeys (Grigor et al., 1995) has suggested that this acute pain may depend on the age at which the birds are trimmed and the method of beak trimming. In this study 3 different methods of trimming were used; cutting with secateurs, a heated blade debeaker or a high voltage electrical discharge (Bio-beaker, Sterwin Laboratories, Millsboro, Delaware, USA). No behavioural evidence of acute pain during trimming using secateurs was observed in turkeys trimmed at 6 or 21 days of age. Trimming with the heated blade produced escape behaviour and vocalisation suggesting they perceived the procedure as painful. Vocalisation and escape behaviour were also observed with the Bio-beaker when used
on 1-d-old chicks. Although there were some slight behavioural differences between the control and the beak trimmed birds there was no clear evidence of pain-related behaviours such as beak guarding in the trimmed birds at any period after trimming. A similar result was found when beak trimming laying hens with either securateurs or hot blade debocker at 1- or 10-d-old (Gentle et al., 1997).

In these two recent studies (Gigor et al., 1995; Gentle et al., 1997) anatomical studies were also performed on the beaks up to 42 d after trimming (Gentle et al., 1995; Gentle et al., 1997). All methods resulted in the loss of a significant amount of beak tissue. By 42 days after trimming the beak had healed with extensive regrowth, including bone and cartilage formation, and the pattern of regrowth was similar after all trimming methods. In the normal bird the dermis at the tip of the upper and lower beaks contains large numbers of nerve fibres and sensory receptors, but in the beak-trimmed birds the dermal tissue, although well supplied with blood vessels, was devoid of afferent nerve fibres and sensory endings. The neural regrowth following trauma matched that of the surrounding tissue such that there was no extensive scar tissue or neuroma formation. A similar absence of neuromas in the beaks of adult hens was reported after trimming of young birds (Lunam et al., 1996; Dubbeldam et al., 1995) but neuromas were present in the beaks of adult hens which had been severely trimmed at hatch (Lunam et al., 1996). The neural and sensory innervation of the beaks of adult birds trimmed as young chicks showed that there was a clear loss of sensory corpuscles in the trimmed beak compared to the normal beak and there was a high density of small myelinated and unmyelinated fibres, i.e. probably predominantly representing A delta and C fibres (Dubbeldam et al. 1995). This change in the sensory innervation of the beak is reflected in a reduction of large nerve fibres in the trigeminal nerve, reductions in the number of large ganglion cells in the trigeminal ganglion, and a reduction in the volume of the principal sensory trigeminal nucleus in the brain (Dubbeldam et al., 1995).

Beak trimming in adult hens, unlike chicks, produces evidence of pain related behaviours. These behaviours can be grouped as beak guarding behaviours and consist of a reluctance to use the beak for non-essential activities such as preening or environmental pecking. In one experiment beak guarding behaviour was measured by counting the number of pecks the birds delivered to an attractive visual stimulus before and again 6, 26 and 32 hours after partial beak amputation (Gentle et al., 1991). At 6 hours after amputation the birds continued to peck the same number of times at the stimulus but by 26 hours after amputation there was a significant reduction in pecking indicating pain. These results point to the presence of a pain-free period immediately following amputation, which may last in some birds for as long as 26 hours, after which the birds appear to be in considerable pain. Some recent unpublished observations from our laboratory have confirmed this pain-free period. Birds were trained to peck at an operant key for a food reward. Immediately after amputation the birds continued to peck at the key for food but on the following day, the birds made only tentative pecking movements at the key and were unwilling to peck hard enough to operate the mechanism. Similar pain-free periods are seen in humans after major traumatic injuries especially after full-thickness burns (Robertson et al., 1985; Stein and Stein, 1983). An explanation for this pain-free period may lie in the responses of sensory afferents. Although the heated blade produced a massive injury discharge in the sensory fibres of the beak for several hours after this discharge there was no further abnormal neural activity in the sensory fibres running to the amputated stump. This absence of abnormal activity in the sensory afferents could provide a mechanism to explain this pain-free period (Gentle, 1991).
(b) Chronic pain

Beak trimming in adult birds presents a very different picture to beak trimming in chicks and there is evidence of possible chronic pain in the adult animal. Behavioural changes which could be interpreted as indicative of pain have been observed for long periods after trimming. For at least 5 weeks after amputation there is a significant reduction in the use of the beak for non-essential activities such as preening and exploratory pecking (Duncan et al., 1989). Other non-beak-related activities were also affected with the birds showing persistent increases in the time spent inactive (Duncan et al., 1989). Eskeland (1981) also observed inactivity and dozing which extended to 56 weeks after surgery. Further evidence for pain-related guarding behaviour comes from a study where the birds were presented with drinking water ranging in temperature from 20 to 45°C (Gentle et al., 1990). Partial amputation of the beak resulted in significant behavioural changes with reductions in environmental pecking, beak wiping and head shaking. Pecking at the water presented at 45°C, and drinking at all temperatures, were also reduced after amputation. These behavioural changes have been interpreted as instances of guarding behaviour and hyperalgesia which persists for at least 6 weeks, 3 weeks after the beak had healed. Wall (1979) has suggested that there are several phases in response to painful injuries in animals. The immediate phase, which is often painless, is followed by the acute phase which is characterised by a combination of tissue damage, pain and anxiety. This acute phase is followed by healing and recovery or it leads to the chronic pain phase which is characterised by increased sleep, inactivity and disturbances of eating, grooming and social behaviour. Many of the behavioural changes associated with beak trimming in adult birds could result from a chronically painful condition and depression (Fraser and Quine, 1989).

In the days that following amputation electrical recordings from the nerve fibres in the stump of the beak show features not seen in normal trigeminal afferent fibres (Breward and Gentle, 1985). The most characteristic abnormality encountered in the beak stump was the presence of large numbers of spontaneously active nerve fibres with either regular, irregular or bursting discharge patterns. These abnormal responses were recorded from the beak stump at 5 to 83 days after initial amputation and the receptive fields of these fibres were located on the distal tip of the stump and at varying distances (up to 12 mm) proximal to it. This spontaneous activity seen in the amputated stump was similar to that observed in the experimental neuroma preparations developed initially by Devor, Wall and co-workers (Devor and Bernstein, 1982; Govrin-Lippmann and Devor, 1978; Wall and Gutnick, 1974) in the rat and later extended to the mouse (Scadding, 1981) and cat (Blumberg and Janig, 1984).

Provided the amount of tissue removed is moderate, beak trimming in chicks does not result in neuroma formation that persists to adulthood. Severely trimmed beaks did produce neuroma which persisted in mature hens (Lunam et al., 1996). In an anatomical study of the nerves in the beak of 5 week old brown leghorn birds from 1 hour to 70 days after amputation (Gentle, 1986), it was found that the beak had a limited ability to regenerate normal beak structure in these older birds. By 15 to 30 days after amputation the stump had healed. The beak then continued to grow but the normal dermal structure did not regenerate. The healed stump contained a continuous layer of epithelium with outer keratin sheath overlying an extensive area of scar tissue. Adjacent to the scar tissue the damaged and regenerating nerve fibres formed extensive neuromas and it is likely that these neuromas give rise to the abnormal neural activity.

Studies on peripheral nerve injury and subsequent neuroma formation in mammals have suggested that abnormal activity arising from regenerating axons are implicated in post-amputation stump pain (Seltzer et al., 1991; Wall, 1981) and similar conditions would apply to beak trimming in the chicken. Although neuromas have been identified in the beak together with abnormal neural activity it does not follow that all birds will suffer long term chronic pain.
In human patients stump and phantom pain is reported to occur in about 70% of patients within the first 2 years after amputation (Jensen et al., 1983, 1985). The pain is generally believed to fade away and finally disappear except in 5 to 10% of patients where pain persists and may even worsen with time (Melzack, 1971). If similar conditions apply to the chicken then we might expect the same proportions of animals to suffer pain as a result of beak trimming.

(c) Sensory deprivation

The beak of both the chicken and turkey receives an extensive nerve supply from the trigeminal nerve and contains large numbers of sensory receptors which are important for touch, temperature and nociceptor sensitivity. In the lower beak of the chicken there are 15-20 dermal papillae which extend into the thick keratin of the exterior of the beak and contain large numbers of encapsulated sensory endings and free nerve endings (Gentle and Breward, 1986), forming a specialised beak tip organ. The upper beak does not have these sensory papillae but the dermis at the tip of the upper beak contains very large numbers of sensory endings. The large number of receptors at the tip provides the animal with a higher resolution of tactile sensory information from the beak tip and enables the animal to perform the complex manipulative tasks associated with the beak. Beak trimming removes this sensitive area of the beak and although significant regrowth of the beak occurs in young birds the regenerated beaks contain fewer sensory corpuscles (Dubbeldam et al., 1995; Lunam et al., 1996).

This altered sensory perception may impair the ability to pick up food; the impairment is especially marked in the case of particulate diets (Gentle et al., 1982) to the extent that, if too much beak is removed and the birds have access only to pellets, it can result in greatly increased mortality (Deaton et al., 1987). It has been shown that beak trimming adult hens (Gentle et al., 1982) reduced feeding efficiency (number of pecks per gram of pellets ingested) to only 20% of its pre-operative value. Frame-by-frame analysis of cine film showed that the bird was either failing to grasp the pellet in the beak, or not transferring it to the pharynx where it could be swallowed. The adult bird could not adapt its stereotyped behaviour pattern to compensate for the altered beak shape. The re-shaped beak following beak trimming is also inappropriate for feeding in young chicks. Reduced feeding efficiency was seen in beak trimmed chicks; non-trimmed birds were observed to swallow a significantly higher proportion of the seed (Workman and Rogers, 1990). Hogan (1973) has proposed that the tactile feedback generated from pecking seeds forms a reward system which develops during the first 2 days of life. During the first week of post-hatching life it is likely that the mandibulation and ingestion of food items constitute two separate feedback reward systems, the post-ingestional reward systems not developing until at least 4 days after hatching. This proposal by Hogan was taken further by Workman and Rogers (1990) who suggested early pecking preferences are influenced by the reward gained from tactile cues supplied from the beak regardless of whether the food is swallowed. Beak-trimming appears to increase the importance of feedback from post-ingestional factors of nutrition relative to that of tactile input. These findings may have some relationship to "starving-out" (i.e. chicks which starve because of an inability, or refusal, to eat during the first 3-6 days of post-hatching life). The period when starve-outs are most common occurs during the critical period of food learning. This data would suggest that beak trimming may reduce food intake in young chicks and so increase the number which die through starvation or, at least, are underweight.

IV. MECHANISMS OF ACTION OF BEAK TRIMMING

In general the poultry industry considers beak trimming to be an important procedure for the control of feather pecking and cannibalism especially in laying hens which are not kept in
battery cages. Although beak trimming is widespread there is evidence that trimming is not always completely effective (Hughes and Michie, 1982; Denbow et al., 1984; Leighton et al., 1985). In the UK growing broilers are not trimmed and neither are growing turkeys although it is necessary to trim breeding turkeys because of the high light intensities required for photostimulation to bring them into breeding condition. Breeding turkeys which are not beak trimmed are at a considerable risk from cannibalism (Grigor et al., 1995).

The situation varies considerably for other species. For some species of duck, such as Muscovies, beak trimming is essential if they are to be kept under intensive conditions, whereas in others, such as Pekins, it is not necessary (Rauch et al., 1993). Guinea fowl kept intensively and beak trimmed show a reduction in food intake and growth rate with no concomitant economic benefits (Oguntona et al., 1988), whereas in the case of pheasants it is essential either to beak trim them or take other steps to prevent damaging pecking, such as fitting bridles (Faure et al., 1993).

At present we do not know why beak trimming is effective and the reasons may differ depending on the age at which the birds are trimmed. Two hypotheses have been considered for beak trimming young birds (Hughes and Gentle, 1995).

1. Trimming shortens the beak making accurate pecking difficult. Pecking becomes less rewarding and this results in a stable, learned inhibition of pecking.
2. Failure to fully regenerate the sensory innervation of the beak results in incomplete sensory feedback which reduces pecking. There is no evidence of pain resulting from beak trimming young birds but in older animals the possibility of pain is very much greater so in older animals there is a third hypothesis.
3. Chronic pain state originates from the amputated stump which reduces pecking.

It seems possible that following beak trimming of older birds, one if not all of these hypotheses would apply. In the chick however there is no evidence of pain being a factor and beak regrowth is so rapid and effective that in a short period of time after trimming the birds are physically capable of feather pecking (Grigor et al., 1995; Gentle et al., 1995; Gentle et al., 1997). A study by Hughes and Michie (1982) concluded that it was the act of beak trimming itself which had the effect and subsequent beak regrowth was irrelevant. In the absence of any further experimental evidence all we can say is that either hypothesis or both may be correct.

V. CONCLUSIONS

It is recognised that feather pecking is influenced by a number of different factors including light intensity and type of housing, social factors such as group size and stocking density (Hughes and Duncan, 1972; Blockhuis, 1989), genetic factors (Cuthbertson, 1980) and a variety of other different motivational factors (Allen and Perry, 1975; Savory, 1994). Given the variety of factors involved it is not surprising that feather pecking and cannibalism have been very difficult to control without beak trimming. If beak trimming is necessary then there are a number of factors which need to be considered. The first is the age at which the birds should be beak trimmed. From our research beak trimming of chicks does not give rise to any long-term painful consequences and therefore it would be best limited to chicks. At present it is not possible to recommend the best age. It seems that fewer complications are likely to occur if the birds are trimmed after they have learnt to feed and in the UK most turkey producers trim at either 6 or 21 days of age. In the chicken a number of commercial producers tend to trim at 10 days of age although trimming at the hatchery is still common. The second factor is the amount of beak which should be removed. For the general welfare of the bird the least amount of beak which will control cannibalism should be removed. This will depend on the strain of the bird.
and the rearing conditions but the complications resulting from severely trimmed birds reported by Lunam et al. (1996) should be avoided. It is also important to remove enough beak to prevent the need to trim a second time at an older age. In the UK the aim is to remove approximately a third of the upper beak of the turkey which can be reliably performed with secateurs. In a series of experiments (Grigor et al., 1995) we found that using a hot blade debeaker or the Bio-beaker removed a variable amount of beak but considerably more of the beak than with the secateurs. The effectiveness at reducing cannibalism in all three methods depended on the amount of beak removed. Therefore, because of the precision of the secateurs method, to control cannibalism effectively in the turkey it might be better to remove slightly more of the beak with secateurs.

Although the adverse effects of beak trimming chicks is relatively minor it is a traumatic procedure which deprives the bird of an important source of sensory information. It has been known that for many years that the incidence of feather pecking and cannibalistic pecking differs between different breeds and stock of domestic fowl (Hughes and Duncan, 1972; Robinson, 1979; Craig and Lee, 1990; Blokhuis and Beuving, 1993) and in future poultry geneticists need to incorporate behavioural/welfare traits in their selection programmes to prevent the need to beak trim birds.

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