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Effect of the analgesic butorphanol on activity behaviour in turkeys (*Meleagris gallopavo*)

T. Buchwalder [a,*], B. Huber-Eicher [b]

[a] *Division of Evolutionary Ecology, Department of Biology, University of Bern, 3012 Bern, Switzerland*
[b] *Centre for Proper Housing: Poultry and Rabbits, Swiss Federal Veterinary Office, Burgerweg 22, 3052 Zollikofen, Switzerland*

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Abstract

During fattening, the bodyweight of modern broad-breasted turkeys increases considerably within a very short space of time. In particular, the breast muscles increase disproportionately. This leads to a disadvantageous distribution in weight, and as a consequence, to a disturbed leg position and skeletal deformations like antitrochanteric degeneration, tibial dyschondroplasia, bending, twisting and rotation of the tibia, osteochondrosis, osteomyelitis, rickets, and epiphyseolysis of the femoral head increases. This cases of degenerative joint disease cause severe pain in humans and there are indications that this is also true for turkeys. The purpose of this study was to determine if behaviour indicative of such pain in turkeys of the B.U.T. Big 6 breeding line could be attenuated by administering a quick-acting analgesic, butorphanol. Twelve pairs of turkeys were tested at the ages of 7 and 12 weeks. One bird in each pair received an analgesic opioid injection, while the other one received a control injection of physiologically balanced saline solution. The time the birds spent putting weight on their legs, i.e., 'walking' and 'standing' and the distance covered by the birds were recorded during the 30 min periods before and after the application of the drug. At week seven the treated birds spent significantly more time putting weight on their legs than control birds. At week 12, the same tendency was observed. No significant differences were found in the distances covered by the animals.

It is concluded that fattening turkeys reduce the time they are putting weight on their legs because these behaviours may be associated with pain.

Keywords: Turkeys; Analgesic; Butorphanol; Pain; Activity; Leg disorders

1. Introduction

Over the last 20 years fattening turkeys have been selected intensively for body weight gain and food conversion efficiency (Sheridan et al., 1978). Together with the simultaneous optimisation of the mixture of feed, a strong increase in the amount of consumable meat, in particular the breast muscle, was achieved (Edwards and Sørensen, 1987). The weight of unselected adult male turkeys is about 8 kg whereas the weight of broad-breasted adult male turkeys is now more than 30 kg (Abourachid, 1991; Sørensen, 1992; Prichard, 2002).

The disproportional increase of the breast muscle leads to a physiologically unbalanced weight distribution and to a modification of motion sequences. Bones and joints are stressed excessively (Abourachid, 1993). As a consequence, the leg position of the turkey changes and the frequency of skeletal problems like antitrochanteric degeneration (Duncan et al., 1991), tibial dyschondroplasia (Leach and Lilburn, 1992), bending, twisting and rotation of the tibia (Sørensen and Harlou, 1984), osteochondrosis (Julian, 1985), osteomyelitis, rickets (Riddell, 1980) and epiphyseolysis of the femoral head (Riddell, 1980; Julian, 1985; Duff and Randall, 1987) increases.

* Corresponding author. Present address: Centre for Proper Housing: Poultry and Rabbits, Burgerweg 22, CH-3052 Zollikofen. Tel.: +41 31 915 35 19; fax: +41 31 915 35 14.
E-mail address: theres.buchwalder@bvet.admin.ch (T. Buchwalder).

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In recent years a considerable number of investigations on fattening turkeys reported very high incidences of skeletal leg disorders (Duncan et al., 1991; Prichard, 2002). Most of the investigations describe relatively young, growing, meat producing birds (Riddell, 1975, 1980, 1981; Walser et al., 1982; Julian, 1985; Julian and Bhatnagar, 1985; Sørensen, 1992). The incidence of tibial dyschondroplasia peaks at 12 weeks of age. At this age, 79% of the toms and 66% of the hens of a heavy breeding line from Nicolas Turkey Breeding (Walser et al., 1982) and 89% of the toms and 74% of the hens of a Goubin strain (Cherel et al., 1991) were affected. At 16 weeks of age, examination of the even heavier B.U.T. T9 and Big 6 strains revealed incidences of tibial dyschondroplasia of 88.2% and 90.5%, respectively (Reinmann, 1999). In an other study antitrochanteric degeneration were present in the hip joints of all of 70 examined adult turkeys of the Big 6 breeding line (Duncan et al., 1991). In a flock of 17-week-old turkeys of the heavy Hybrid Turkey line, 98% of the birds showed an abnormal gait (Classen et al., 1994). Reported rates of generative hip disorders among male breeding turkeys range from 90% to 100% and all birds showed reluctant walking (Duff, 1984a,b; Duff et al., 1987). At sexual maturity (27–34 weeks) all female turkeys of a heavy breeding line showed cartilage lesions (Hocking and Lynch, 1991). The Prevalence of antitrochanteric degeneration in large white mail-line turkeys (B.U.T. – M5) was 81% at 54 weeks of age (Hocking et al., 1999). To summarise, all studied hybrids were very seriously affected by degenerative joint diseases.

In domestic animals and human beings degenerative joint diseases cause severe and chronic pain, especially when weight is put on the legs (Haubruge et al., 2000). By analogy and homology, we have to expect that birds with similar joint conditions experience comparable pain (Melzack and Wall, 1982; Harkness et al., 1984; Gentle, 1991; Gentle and Hunter, 1991; Paul-Murphy, 1998). However, until now little research has been conducted to assess pain in birds (Paul-Murphy, 1998). As the sensation of pain cannot be measured directly, behavioural changes as well as physiological responses are still the major parameters used to gauge pain (Keefe and Block, 1982; Zimmermann, 1986; Duncan et al., 1991; Keefe et al., 1991; Sweet and McGrath, 1998; Paul-Murphy and Ludders, 2001a). Pain can have very significant effects on the behaviour of humans and animals (Keefe et al., 1991), but in birds, behavioural changes as reactions to pain are subtle, such as slight alteration in posture, changes of perching position, decrease in appetite or a general reduction in activity (Wall, 1979; Loeffler, 1986; Paul-Murphy, 1998; Paul-Murphy and Ludders, 2001a,b). One of the assessment methods commonly used in evaluating pain is to measure behaviour in the presence or absence of analgesia (Keefe et al., 1991). In different investigations on pain related behaviour due to leg weakness in broilers (Geown et al., 1999; Danbury et al., 2000; Hocking et al., 2001) and turkeys (Duncan et al., 1991; Hocking et al., 1999), birds treated with analgesics (carprofen, methylprednisolone or betamethasone) showed more activity than control birds treated with physiological saline. All of the administered analgesics reduce pain within a few days via their action on inflammatory processes. The purpose of the present study was to determine if behaviour indicative of pain in relation to the locomotor system in turkeys of the B.U.T. Big 6 breeding line could also be attenuated by administering a quick-acting analgesic, butorphanol. The opioid butorphanol has been used as analgesic since 1978, in both human medical science as well as in veterinary medicine (Diamond et al., 1992; Hoffert et al., 1995; Reim and Middleton, 1995). It is effectual, both in mammals (Mansour et al., 1988; Gades et al., 2000) and birds (Gentle et al., 1991; Paul-Murphy, 1998; Paul-Murphy et al., 1999). It is the main recommended non-anti-inflammatory and non-anaesthetic analgesic agent for treatments of pain in birds (Paul-Murphy and Ludders, 2001a,b). The known side effects of Butorphanol may be depression of the cardiovascular system and of the spontaneous respiratory activity and cough, alteration in bronchomotor tone, gastrointestinal secretory and motor activity and bladder sphincter activity, stimulation of the emetic centre, miosis and general sedation (Demuth, 2001; US Food and Drug Administration, 1998; Paul-Murphy and Fialkowski, 2001; Paul-Murphy and Ludders, 2001a,b). In combination with other components like Medetomidine it was used as an effective analgesic sedative (Murray and Johnson, n.d.). The behavioural activity of birds receiving analgesic injections was compared with that of birds receiving control injections. We hypothesise that if the time heavy fattening turkeys spend putting weight on their leg joints is limited by pain, then they should increase this time when given an effective analgesic.

2. Animals, materials and methods

32 non-beak-trimmed turkeys of unknown sex of the B.U.T. Big 6 breeding line were purchased from a commercial breeder at five weeks of age. The birds were marked individually with coloured leg bands and randomly assigned to four groups of eight individuals. The groups were then housed in identical pens (4.9 m^2), separated by wire mesh and by solid walls made of plywood up to a height of one metre. The pens were littered with wood shavings and straw and contained a suspended bell-drinker (diameter 40 cm), a feeder (diameter 50 cm), a straw bale and a perch (180 cm, height 60 cm). Temperature was maintained between 15 and 20 °C. Artificial light was provided from 0600 to 2000 h with a 15 min twilight phase at the beginning and the end of the day. Light intensity at the height of the animals was 30 lx.

2.1. Procedures

As it turned out the four groups were composed of 25 males and 7 females. In each group of eight birds, three pairs of birds with similar bodyweight (max. 15% difference) were chosen as test pairs (sex-independently). Pairs were tested twice (weeks 7 and 12). Tests took three days to complete, with four pairs tested (one from each group) a day.

The birds in a test pair were individually marked on their backs with black hair spray and brought into a separate experimental pen (4.9 m^2) containing a suspended bell-drinker. After 25 min of habituation, behaviour and movements of the animals were observed and additionally recorded on video for 30 min. The drug was then administered. One bird received an intramuscular injection of the analgesic Morphasol, a commercial preparation containing the active ingredient butorphanol (0.5 mg/kg), a synthetic opioid which reduces pain via mixed-agonist-antagonist reactions (Paul-Murphy, 1998), while the other bird received a similar volume of physiologically balanced saline solution (control) into the breast muscle (Reim and Middleton, 1995; Paul-Murphy and Fialkowski, 2001; Paul-Murphy and Ludders, 2001a). Indications of dose rates vary widely among different studies (0.1–4 mg/kg; Reim and Middleton, 1995; Gades et al., 2000; Paul-Murphy and Fialkowski, 2001; Paul-Murphy and Ludders, 2001a; Paul-Murphy, 2002). Recent studies evaluated, that Butorphanol is a more efficacious analgesic in birds than in mammals (Mansour et al., 1988; Paul-Murphy and Ludders, 2001a) and that species variability in response to opioids does occur (Paul-Murphy and Fialkowski, 2001). To avoid too strong depressive and sedative effects we chose the relatively low dose rate of 0.5 mg/kg of butorphanol. The maximum concentration of butorphanol in the blood occurs 30–60 min after injection (Demuth, 2001; US Food and Drug Administration, 1998). Therefore, the second observation session with behavioural observations and video recording lasting 30 min, started 45 min after the application of the drug.

2.2. Behavioural observations

Simultaneous observations of both animals were carried out from a central corridor. Using the program 'Observer' (Noldus Information Technology, Wageningen NL) the duration of two mutually exclusive behavioural categories were recorded: behaviour while no body weight rests on the joints of the legs (sitting or lying) and behaviour while weight is put on the joints (standing or walking). Additionally, the distance covered by the birds during the observation period was recorded transmitting the movements of the birds, i.e., the way covered by the birds, with a permanent marker from the video screen to a plastic foil. The length of the lines marked on the foil were then measured with a scroller for distance measurements on geographic maps.

2.3. Statistical analysis

The effect of group affiliation was verified by analysis of variance (Siegel and Castellan, 1988). Since no group effects were detected, neither in week seven nor in week 12, all test pairs were treated as independent observational units. For the behavioural measurements and for the distances covered, the ratio between the test and control bird in a pair was calculated. The ratios before and after application of the drug were then compared by means of Wilcoxon signed ranks test for matched pairs (Siegel and Castellan, 1988). In one test in week 7 the control bird lay one the floor for the whole observation time after the treatment and the ratio of this test pair could therefore not be calculated. All tests are two sided and alpha level was set to 5%.

3. Results

Control birds lay on the floor for more than half of the observation time (965 s out of 1800 s) in week 7, and for almost two thirds of the observation time (1133 s of 1800 s) in week 12.

At seven weeks of age, turkeys treated with analgesic spent significantly more time putting weight on their legs than control birds (Wilcoxon signed ranks test for matched pairs, $N = 11$, $T = 7$, $P = 0.02$, Fig. 1). In week 12 the animals tended to show a similar reaction, however, the difference did not reach statistical significance ($N = 12$, $T = 15$, $P = 0.07$).

During the observation time, control birds covered an average distance of 27.5 m (min. 0.1 m, max. 70.0 m) and 11.9 m (min. 2.3 m, max. 66.8 m) in weeks 7 and 12, respectively. The ratio of the distances covered by treated and control birds before and after the application of the analgesic was not significantly different, neither in week seven nor in week 12 (Wilcoxon signed ranks test for matched pairs, $N = 12$; week 7: $T = 39$, $P = 1$; week 12: $T = 34$, $P = 0.7$; Fig. 2).

4. Discussion

The analgesic Butorphanol had the expected effect. Seven-weeks-old broad-breasted fattening turkeys treated with the analgesic put weight on their legs significantly longer than control animals. A tendency ($P = 0.07$) for a similar effect was found in week 12.

The fact that 7 and 12 weeks old birds got the same dose of the analgesic relatively to their body weight (and not relatively to the seriousness of their lesions)

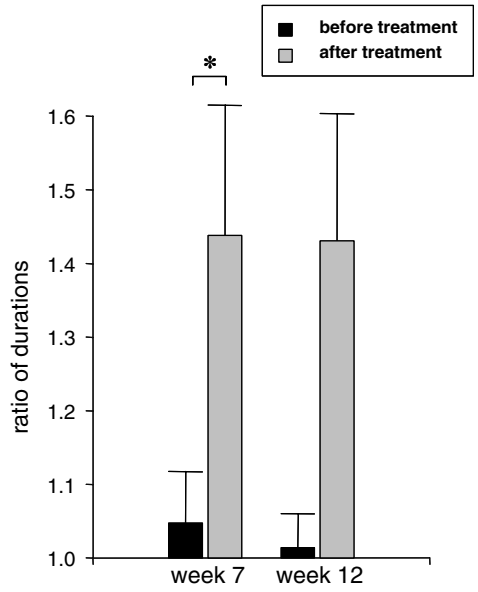

Fig. 1. Ratio between the durations of time that treated birds and control birds put weight on their legs, both before and after the application of an analgesic at 7 and 12 weeks of age. Error bars represent standard deviations.

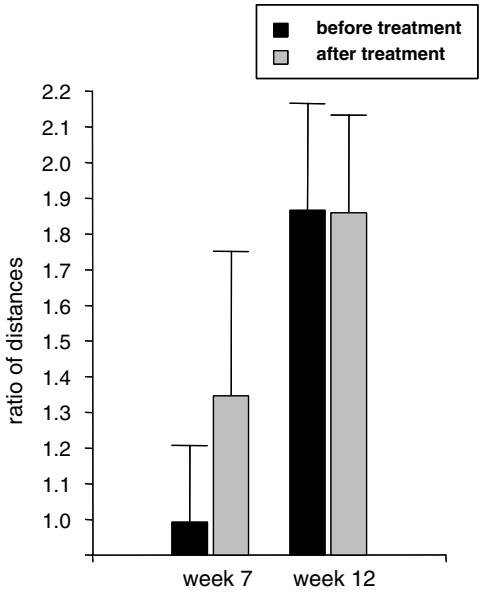

Fig. 2. Ratio between the distances covered by the treated and the control birds, before and after treatment at 7 and 12 weeks of age. Error bars represent standard deviations.

and the evidence that 12 weeks old birds suffer from greater lesions than 7 weeks old birds (Walser et al., 1982; Cherel et al., 1991) could be an explanation for the smaller difference in activity behaviour between the treated and the control birds in week 12.

Possible side effects of the opioid butorphanol are among others a general sedation, a depression of the cardiovascular system and of the spontaneous respiratory activity and cough but no increase in general activity (Demuth, 2001; US Food and Drug Administration, 1998; Paul-Murphy and Fialkowski, 2001; Paul-Murphy and Ludders, 2001a,b) and the difference between the treated and the control birds might therefore have been even larger than observed. Butorphanol is known to have a pain-reducing effect in animals and man and we therefore conclude from our results, that fattening turkeys reduce the time they are active, i.e., standing and walking because these behaviours are associated with pain. Taking into account the many studies reporting very high prevalence of up to 100% of gait problems and degenerative joint diseases in fattening turkeys, it seems probable that the pain indicated by the observed behavioural changes is caused by pathological alteration of the locomotor system of the legs. Foot pad dermatitis as a source of pain can be excluded as the foot pads of the tested animals were monitored in weeks 7 and 12 but no lesions nor ulcerations were observed.

No significant effect of the analgesic on the distance covered by the birds was detected. Turkeys are group living birds, their behaviour is synchronised within the group (Williams, 1981) and we may expect a high motivation in individual birds to stay together with group members. This might have led to a levelling of the distances covered by the test and the control bird. However, it could also be, that walking was less affected by the analgesic than standing, meaning that walking would be less painful for the birds. Unfortunately, our data does not allow further investigation of this question, but it would be interesting and worthwhile to study such possible differences in pain sensation when 'walking' or 'standing' using an experimental approach.

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