Tail Switch Removal in Dairy Cows

Cortisol and behavioural responses to tail switch removal by two methods, with and without local anaesthetic, in dairy calves (2006-CO149)

MAF Biosecurity New Zealand Technical Paper No: 2009/07

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ISBN 978-0-478-33892-8 (Print)
ISBN 978-0-478-33893-5 (Online)

ISSN 1176-838X (P)
ISSN 1177-6412 (O)

April 2008

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

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1. Summary

The effects of tail switch (the distal 2-3 vertebrae and associated hair) removal techniques on stress were evaluated in 3-6 week old dairy calves. Tails switches were removed using either a rubber ring or a hot-iron, with or without local anaesthetic and physiological and behavioural measures undertaken on the day of treatment and the day after.

Plasma cortisol concentrations were similar in untreated and rubber ring-treated calves, but significantly elevated for up to 60 minutes in animals treated with the hot-iron. The provision of local anaesthesia reduced the magnitude of the cortisol response to the hot-iron. Behavioural observations indicated calves were mostly standing or lying immediately after treatment with no evident differences in tail shaking, vocalizing, rumination or other pain-related behaviours. There were no obvious differences in the behaviour of calves treated by either method and no effects of local anaesthesia.

These acute responses to switch removal in young calves suggest that it is a relatively benign procedure despite some differences between rubber ring and hot-iron methods. Nevertheless, on the basis of these results the ring method without local anaesthetic use, and *not* the hot-iron whether or not local anaesthetic is used, should be recommended.

1.1 PROGRAMME GOAL AND RATIONALE

1.1.1. Goal:

To describe short-term and long-term animal welfare consequences of tail switch removal in dairy cows

1.1.2. Rationale:

The Animal Welfare (Painful Husbandry Procedures) Code of Welfare 2005 permits switch removal in Minimum Standard No. 4(d) –Tail docking, as follows:

If tail shortening is undertaken it must be limited only to removal of the last (terminal) two or three vertebrae of the tail, using a rubber ring applied between the joints, and either:

- be left to drop off; or
- not less than seven days after the application of the rubber ring, be severed by the use of a sharp instrument at a point below where the rubber ring has been applied and in such a manner as not to cause discomfort to the animal.

Acute (short-term) cortisol stress responses and behavioural effects of tail docking of dairy calves and heifers have been reported (Petrie et al 1995, 1996; Tom et al 2002). Generally the effects on calves seemed to be mild to moderate, and then in only about 20 percent of those to which rubber rings were applied (Petrie et al 1995, 1996). Docking in these cases was conventional, occurring high on the tail. In addition, the rubber ring method was compared with use of the docking iron (Petrie et al 1996). The iron method was found to elicit mild stress responses in a small proportion of the animals, but it had the disadvantage of a significant incidence of haemorrhage from the cauterised tail stump.

To date, however, stress effects of switch removal, which by definition is limited to the distal end of the tail, have not been assessed, but the impact of switch trimming (clipping off the long tail hairs) on the effectiveness of fly-deterring behaviours has been outlined in an unpublished report (Matthews et al 1995).

There is a general perception that the sensitivity of the tail to noxious insult progressively diminishes in a proximal to distal direction. It is possible therefore, that switch removal using a rubber ring will not elicit a significant stress response, but this remains to be determined. Moreover, the incidence of haemorrhage may be less when tail severance with a docking iron occurs at the distal end rather than proximally because of the smaller diameter of the distal tail itself and, presumably, the presence of smaller blood vessels; but this too remains to be determined.

Note, however, that use of the docking iron is not included in the 2005 Code, only rubber ring use, so that at present docking iron use is excluded. If the iron were found to be as effective for tail switch removal as the ring (e.g. minimal or no haemorrhage) and to cause no more stress in each affected animal and in no greater proportion of all the animals docked, there may be a case for NAWAC to consider including the iron as an acceptable method along with rubber rings. Practically, it would have the additional advantage that there would be no need to remove the dead remnant of the distal tail, as may be done from seven days after ring application, because the iron method achieves that at the time of its application. In this context, there would be value in comparing the behaviour of calves in relation to the nature of the tail lesions caused by the ring and iron, and in relation to the extent of healing in each case, during the period after docking until complete healing occurs.

The results and our recommendation are contained in this final report.

1.2 REFERENCES

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2. Introduction

The acute (short-term) cortisol stress responses and behavioural effects of conventional tail docking of dairy calves and heifers have been reported (Petrie et al 1995, 1996; Tom et al 2002a). Generally the effects on calves seemed to be mild to moderate, and were seen in only about 20 percent of those to which rubber rings were applied (Petrie et al 1995, 1996). When the rubber ring method was compared with the docking iron (Petrie et al 1996) the latter was found to elicit mild stress responses in a small proportion of the animals, but sometimes there was haemorrhage from the cauterised tail stump. The restless behaviour and rumination of calves experiencing ring application was different from those of control calves in the day following treatment suggesting that the calves may still have been experiencing some mild pain at that stage (Petrie et al., 1995). Likewise, at most mild discomfort was apparently caused by ring application to the tails of lactating adult cows, as the procedure caused only small changes in tail-related behaviour and had no significant effects on feed intake and milk production during the following six days (Tom et al., 2002b).

The animal welfare code for painful husbandry procedures does not allow tail docking but allows removal of the distal end of the tail, i.e. the switch, by ring application (Anonymous, 2005). To date, the stress effects of such switch removal have not been assessed. There is a general perception that the sensitivity of the tail to noxious insult progressively diminishes in a proximal to distal direction (Fisher and Gregory, 2007). It is possible therefore, that switch removal using a rubber ring will not elicit a significant stress response, but this remains to be determined. Moreover, the incidence of haemorrhage may be less when tail severance with a docking iron occurs at the distal end rather than proximally because of the smaller diameter of the distal tail itself and, presumably, the presence of smaller blood vessels; but this too remains to be determined.

Changes in plasma cortisol concentrations are very well established as a valid index for assessing acute physiological stress responses to painful husbandry procedures (Mellor and Stafford, 1999, 2000; Mellor et al 2000; Stafford and Mellor 2005a,b), as are selected behavioural responses (Mellor et al 2000; Stafford and Mellor 2005a,b). Accordingly, the cortisol and behavioural responses of calves to tail switch removal were measured and the animal welfare implications of this procedure were assessed.

3. Materials and methods

Forty-nine calves aged 3-6 weeks and weighing 70-80 kg, were randomly divided into seven groups each of seven calves. The trial was carried out over two days with 21 calves (3 calves per group) receiving treatment on day 1 and 28 (4 calves per group) on day 2. On the afternoon before each trial day the calves were housed in an open-fronted calf shed where the research was to be conducted. Food, but not water, was withheld over night. Each calf was numbered non-invasively and allocated randomly to one of the seven groups. At least 1 hour before the start of the trial on each day, calves were moved quietly into more restricted pens to facilitate treatment.

Treatment groups included:

- Control

Calves were caught and held firmly against a pen wall by two people, to allow blood sampling from a jugular vein and all other procedures, but the tail switch was not removed

- Ring switch removal (ring)

Each calf was caught and held as for control calves and a ring was placed about 2 cm above the tip of the tail at the proximal margin of the switch. The tail tip plus switch were left to drop off of their own accord, which occurred 5-8 weeks after ring application.

- Hot iron switch removal (iron)

Each calf was caught and held as for control calves and the hot iron (gas-heated; Petrie et al 1996) was applied about 2 cm above the tip of the tail and the switch was removed.

- Local anaesthetic control (LA)

Each calf was caught and held as for the controls and a "ring-block" of local anaesthetic (2ml Nopaine, 2 percent lignocaine hydrochloride; Phoenix Pharm Distributors, Auckland) was injected into the distal tail about 20 cm proximal to the amputation site 15 minutes before the designated time of treatment, but the tail switch was not removed.

- Local anaesthetic plus rubber ring switch removal (LA ring)

Each calf was caught and held as for the controls and local anaesthetic placed as described above, and then a rubber ring was placed about 2 cm above the tip of the tail.

- Local anaesthetic plus iron switch removal (LA iron)

Each calf was caught and held as for the controls and local anaesthetic placed as described above and then the switch was removed by hot iron as described.

- Adrenocorticotropic hormone injection (ACTH)

ACTH (1.25 ml/calf; Synacthen, 0.23 mg ACTH/ml; Novartis, New Zealand) was injected into a jugular vein of each calf 15 minutes before the designated time of treatment, but the tail switch was not removed.

Blood samples were taken from a jugular vein by venepuncture into heparinised vacutainers, 20 minutes and immediately before treatment (time 0) and at 20, 40, 60, 80, 100, 120, 150, 180, 210 and 240 minutes after treatment. The duration of this post-treatment sampling was determined by our previous experience (Petrie et al 1996). Samples were immediately placed on ice and later centrifuged at 3,000 rpm for 15 minutes. Plasma was harvested and stored in at -20^{o}C until assayed for cortisol. When all blood samples had been taken the calves were

released into a nearby paddock. Cortisol was assayed using radio-immuno-assay kits from DSL (Diagnostic System Laboratories Inc, Texas, USA). I-125 labelled antigen bound to antibody. Details of assay: minimum detectable concentration was 5ng/ml; the inter- and intra-assay coefficients of variation were <10 percent.

The behaviour of the calves was monitored after treatment as follows: tail movements, licking, vocalising, standing/lying and eating/rumination. Observations were carried out on individual calves at 30 minute intervals from time 0 for 8 hours on the day of treatment and for 3 hours on the day following treatment. The crowding of the animals in small pens in order to minimise the stress of blood sampling restricted the calves' behaviours for the first 4 hours.

3.1 DATA ANALYSIS

The cortisol concentration data were collated and the initial pre-treatment value (at -20 minutes) was subtracted from all subsequent values for each calf. The resultant data were normally distributed.

The cortisol data are expressed as the mean $\pm$ standard error of the mean (SEM) at each time for each treatment. The significance of the difference between means was determined using two-way analysis of variance (ANOVA). A general linear model was used to analyse the cortisol concentrations data at each time point. The model included treatment as a fixed effect.

The integrated response (area under curve) was calculated to give a single measure of the magnitude and duration of the plasma cortisol response following treatment. It was defined as the area between a horizontal line drawn through the pre-treatment value at -20 minutes and the cortisol response after treatment when the concentration was greater than the pre-treatment value (Mellor and Murray, 1989). The total area between the time of treatment and 240 min was calculated for each treatment.

The incidence of different behaviours (eating/ruminating, lying/standing, tail shaking, licking, vocalising) were summed for each treatment group for the first 3.5 hours after the treatments 9.00am, during the following 3 hours and on the next day between 24 and 27 hours after treatment (Table 2).

All statistical analyses were carried out on SAS (V8, SAS Institute Inc, Cary, NC, USA, 2001).

4. Results

There was no significant difference in the mean plasma cortisol concentration before treatment (T = - 20 minutes) between calves in the seven treatments (Table 1). Changes in plasma cortisol concentrations are shown in figures 1, 2, and 3. The ACTH evoked a large plasma cortisol response, which did not return to pretreatment values within the 240 min of the trial (Figure 1). The mean plasma cortisol concentrations in ACTH calves were still significantly greater ($P<0.05$) than the pre-treatment value and the mean control value at 240 min, and were significantly greater ($P<0.05$) than the mean values at all other times in calves given all other treatments.

There were no significant differences at any time between the mean plasma cortisol concentrations of calves that received the control, ring and ring plus local anaesthetic treatments (Figure 1).

The mean plasma cortisol concentrations of calves whose switch was removed by hot iron following local anaesthetic administration were significantly lower ($P<0.05$) than in those that had their switch removed by hot iron without anaesthesia, except at 20 minutes after treatment; they were similar for the rest of the trial (Figure 2). The mean plasma cortisol concentrations of calves whose switch was removed by hot iron following local anaesthetic administration were no different from control animals throughout the trial (Figure 2).

The mean plasma cortisol concentrations of calves whose switch was removed using the hot iron were greater than those of control calves and rubber ring-treated calves at 20, 40 and 60 minutes after treatment (Figure 3).

The integrated cortisol response was significantly greater following ACTH injection than it was for any other treatment, and the integrated response following hot iron use was greater than the that of control calves, but not those following any other treatment (Table 1).

The incidence of tail shaking, vocalising and licking was low (Table 2) and the incidences of the different behaviours across treatment did not suggest any significant pain-related behaviours in the ring and hot iron treatment groups.

Table 1. The mean (SEM) plasma cortisol concentrations (nmole/l) 20 minutes before treatment (pre-treatment), its peak value (nmole/l) and time to peak value (minutes) and the area under the curve (AUC; nmole/l.minutes) for calves subjected to tail switch removal with or without local anaesthetic, and in control calves and calves that received ACTH intravenously (n=7 in all treatments).

Treatment	Pre-treatment	Peak value	Time to peak	AUC
Control	1.7 (1.73)	3.9	120	473
LA	2.7 (1.73)	5.9	20	676
Ring	5.5 (1.73)	5.0	120	354
LA Ring	3.9 (1.73)	13.0	100	1281
Iron	1.7 (1.73)	21.9	40	2381
LA Iron	3.0 (1.73)	12.7	150	1245
ACTH	5.8 (1.73)	56.0	60	7271

Table 2. The behaviour of calves during and following switch removal by hot iron or rubber ring with or without local anaesthetic, and for control handling, ACTH injection and local anaesthetic injection. The data are total incidences of behaviours observed at 30-minute intervals and summed for the periods 0-3.5 hours, 4-8 hours and 24-27 hours after treatment.

	Eating			Ruminating			Neither eating nor ruminating		
	0-3.5h	4-8h	24-27h	0-3.5h	4-8h	24-27h	0-3.5h	4-8h	24-27h
Control	3	18	4	12	6	15	43	20	33
LA	1	20	3	5	4	5	49	23	46
Ring	6	23	4	13	2	5	43	15	52
LA Ring	2	24	1	9	2	6	44	19	40
Iron	2	23	3	8	1	3	48	17	51
LA Iron	4	19	4	9	4	3	49	18	53
ACTH	3	20	5	5	2	5	51	22	49

	Standing			Lying		
	0.3.5h	4-8h	24-27h	0-3.5h	4-8h	24-27h
Control	57	36	21	13	23	48
LA	54	41	19	15	14	53
Ring	55	56	25	11	13	45
LA Ring	57	53	22	14	11	54
Iron	56	56	20	13	10	55
LA Iron	49	54	20	12	14	47
ACTH	55	53	21	13	13	53

	Tail shaking			Vocalise			Licking		
	0-3.5h	4-8h	24-27h	0-3.5h	4-8h	24-27h	0-3.5h	4-8h	24-27h
Control	3	0	0	1	0	0	2	2	3
LA	2	0	0	1	0	0	5	0	5
Ring	2	0	3	0	0	0	1	2	1
LA Ring	4	0	2	1	0	0	1	0	5
Iron	1	1	1	1	1	0	2	2	0
LA Iron	2	0	2	7	4	1	2	0	2
ACTH	7	0	2	0	2	1	2	0	2

Figure 1. Changes in mean (± SEM) plasma cortisol concentrations of calves relative to values 20 minutes before treatment in response to ACTH injection, control handling, switch removal by rubber ring and switch removal by rubber ring following local anaesthetic. Apart from means for the ACTH calves from 20 minutes after treatment, which were significantly higher than corresponding values in the other three groups shown, there were no significant between-group differences.

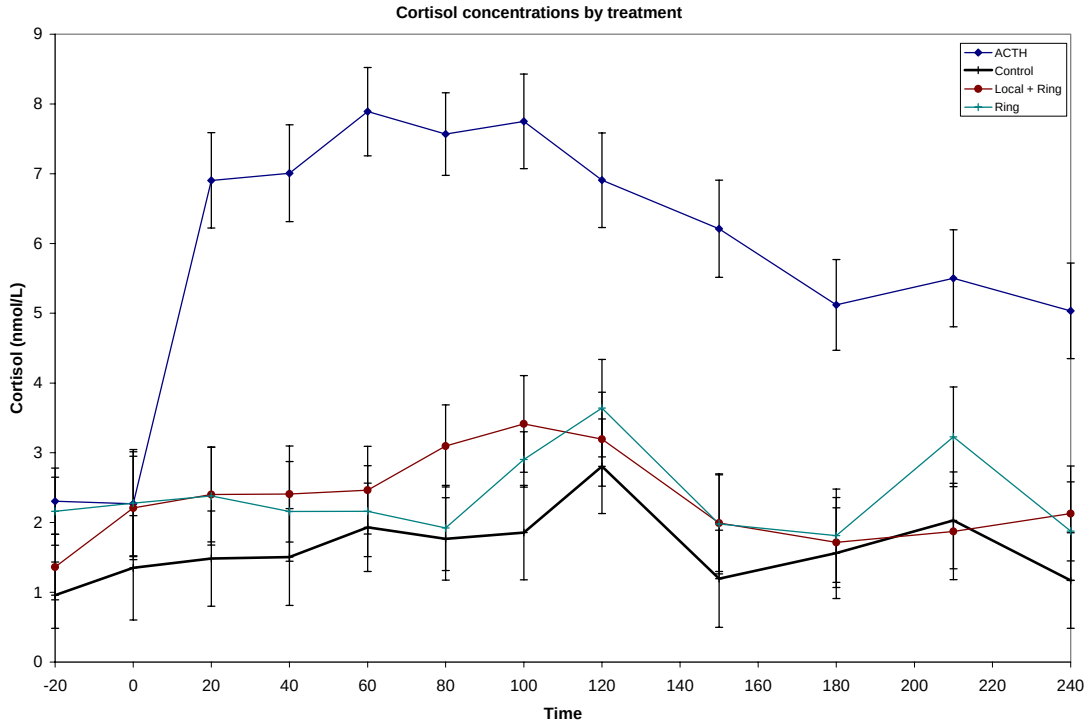


Figure 2. Changes in mean (± SEM) plasma cortisol concentrations of calves relative to values 20 minutes before treatment in response to ACTH injection, control handling, switch removal by hot iron and switch removal by hot iron following local anaesthetic. Means with different letters, or where there is a letter on one mean and none of another at the same time, between groups, are significantly different.

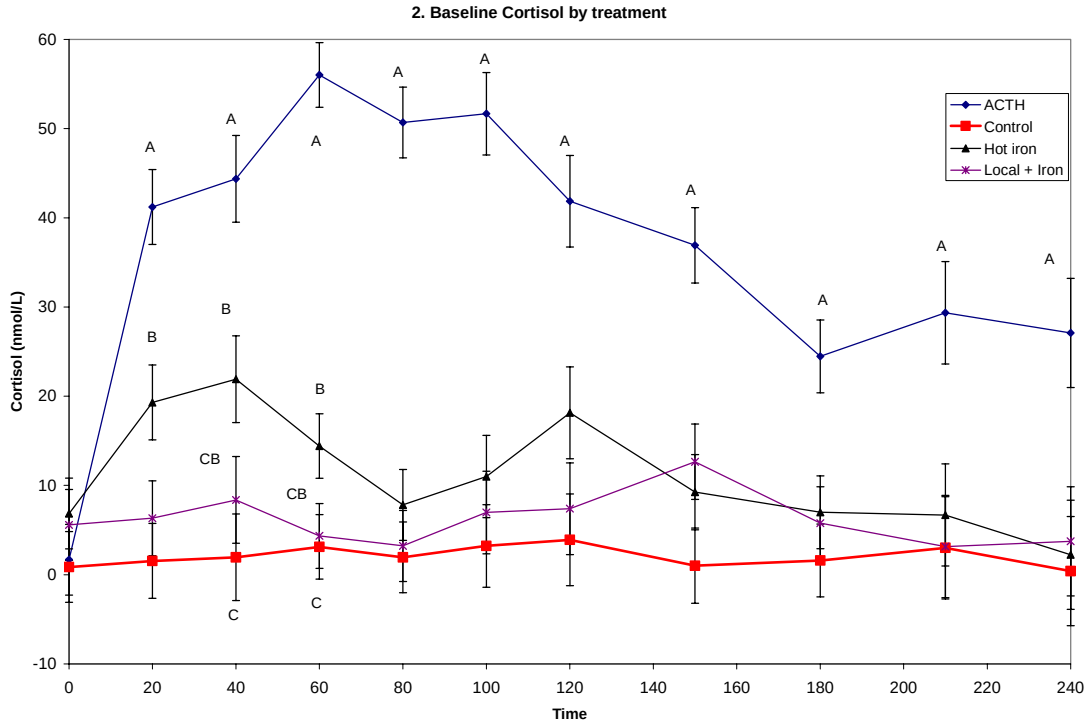
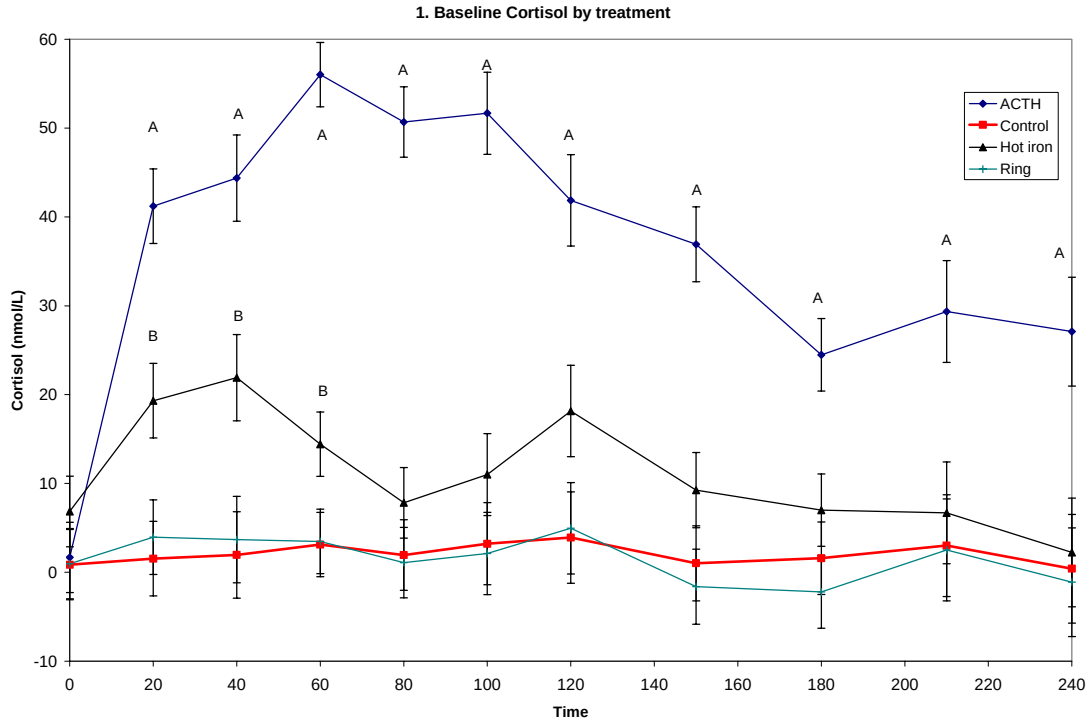


Figure 3. Changes in mean (± SEM) plasma cortisol concentrations of calves relative to values 20 minutes before treatment in response to ACTH injection, control handling, switch removal by hot iron and switch removal by rubber ring. Means with different letters, or where there is a letter on one mean and none on another at the same time, between groups, are significantly different.



5. Discussion

Hot iron switch removal caused a brief but obvious plasma cortisol response which was greater than the response to control and rubber ring treatment at 20, 40, 60 minutes, suggesting minor distress or pain was caused by the former. Rubber ring switch removal caused no significant plasma cortisol response suggesting that it did not cause significant distress or pain. These responses to switch removal by hot iron and rubber ring are similar to those found by Petrie et al (1996) who reported greater plasma cortisol responses to full tail docking by hot iron than to ring docking. However, the plasma cortisol response to hot iron switch removal was much lower than the response to ACTH, suggesting that it was not a very unpleasant experience.

The significant difference 20 minutes after treatment, but at no other time, between the cortisol concentrations in calves subjected to switch removal using the iron, with and without local anaesthetic, is consistent with the view that, overall, the pain and distress experienced with the iron alone were relatively mild. Nevertheless, the absence of a significant cortisol response to ring switch removal indicates that, compared to the iron method, the ring should be recommended.

The behavioural observations were consistent with the view that neither method of switch removal was particularly painful in that there were no obvious differences in the incidence of tail shaking, vocalization or reduced feeding or rumination between the treated calves and the control calves.

The longer term impact of switch *trimming* (clipping off the long tail hairs) on the effectiveness of fly-deterrence behaviours has been outlined in an unpublished report (Matthews et al 1995). Switch trimming (as opposed to switch removal) has been shown to lead to fly avoidance behaviours and reduced success in deterring flies which was generally intermediate between that exhibited by conventionally docked and undocked animals (Matthews et al 1995). Given that this study, albeit unpublished, was extremely thorough, it is questionable whether it is necessary to repeat it simply to compare the effects of tail switch trimming with tail switch removal, which might reasonably be expected to have very similar effects on fly avoidance and deterrence. However, additional factors to be considered may include the incidence of neuromas and the possibility of associated chronic pain, ring-induced wound development and healing before and after the dead tissue drops off or is amputated, balanced against cow cleanliness, faster milking and greater comfort for milkers.

6. Acknowledgements

We are grateful to MAF Biosecurity New Zealand (MAFBNZ) Policy, Wellington, for providing partial financial support for this project, and to Dr ACD Bayvel, MAFBNZ Animal Welfare Directorate, for helpful comments.

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