ABSTRACT: A public debate has recently arisen, largely surrounding the issue of pain, over whether freeze or hot-iron branding should be the preferred method of permanently identifying cattle. This study addressed that question by quantifying the following accepted measures of distress and pain over a 25-min sampling period: elevated heart rate, concentrations of cortisol, epinephrine, and norepinephrine, and escape-avoidance reactions and vocalizations. Twenty-four dairy cows (15 Holsteins and 9 Jerseys) were assigned to one of three treatments: freeze-branded (F), hot-iron-branded (H), or sham-branded (S), in which a room-temperature brander was applied. Plasma epinephrine and norepinephrine concentrations showed no discernible trends. Plasma cortisol concentrations were elevated in the F and H cows from 5.5 min to 25.5 min postbranding ($P = .04$). Heart rate, analyzed as a proportion of the prebranding mean, showed that H cows had a greater, more acute, response than did F cows ($P = .04$), which exhibited a more prolonged response ($P = .07$). No cows vocalized during branding; however, H cows had a greater escape-avoidance reaction toward branding than did the F and S cows. Both methods of branding produced elevated heart rates and cortisol concentrations indicative of pain sensations. Because the cows exhibited a greater escape-avoidance reaction and heart rate proportions to hot-iron branding, freeze banding would be preferable to hot-iron branding when feasible.

Key Words: Branding, Stress, Pain, Cattle

Introduction

Hot-iron branding is a tool used to permanently identify livestock and is thought to have been in practice since biblical times (Paxton, 1982). It was not until 1966 that an alternative method of branding (freeze branding) was established (Ferrel, 1966). Both methods of branding produce permanent, identifiable marks on the animal. Hot-iron branding leaves scar tissue without hair that can also be identified on the hide, whereas freeze branding destroys the pigment-producing cells (causing the hair to turn white) or destroys the hair cell (causing the hair to fall out) with longer application, but does not damage the hide.

Along with the economic pros and cons of each method of branding, there is also the concern of which method is more painful (Hooven, 1988; Animal Welfare Institute, 1986). Other than previous studies conducted in this laboratory (Lay et al., 1992a,b), no studies have been conducted specifically to compare the two methods. In both of our previous studies, in which we used untamed cattle, we found that restraint and handling significantly elevated some physiological measures; therefore, in this study we attempted to eliminate the effect of restraint and handling on physiological indicators of stress by using dairy cows. This study determined which method of branding elicited the greater response in physiological and behavioral characteristics that are commonly accepted as measures of acute distress and/or pain: elevated heart rate, epinephrine (EPI), norepinephrine (NOR), and cortisol concent-
trations in the plasma and avoidance reactions and vocalizations of the animals.

Procedure

Twenty-four mature, lactating dairy cows (15 Holsteins and 9 Jerseys) were balanced by breed and assigned to one of three treatments: 1) hot-iron branded (H), 2) freeze-branded (F), or 3) sham-branded (S). The S cows were subjected to the same handling and restraint as F and H cows, but merely had a room-temperature branding iron held to their skin for 10 s. Among treatments, cows were blocked for time of day and order of treatment to balance for any diurnal or order effects. Six cows received treatments each day, three before noon and three after noon.

Jugular cannulas were established in each cow 1 d before application of treatments. To prevent the possibility of the cows associating the location where the treatments were applied with the stress of cannulation, the cows were cannulated at a facility different from that where they received their treatments. While cows were restrained for cannulation, three square patches of hair were clipped from them. One square patch (20 x 20 cm) was clipped on the left hindquarter for preparation of the brand site. Two more square patches (10 x 10 cm) were clipped for the placement of two 4-0 stainless steel sutures, one on the sternum and one immediately behind the shoulder on the ribs. After application of a topical antiseptic, the stainless steel suture was inserted through the skin in the center of each clipped area and loosely tied, leaving a 1-cm loop. The next day, the heart rate monitoring equipment was attached to these two temporary sutures that served as electrodes. The restrained cows seemed to react to suturing as they would to a normal hypodermic injection.

When each cow was to receive treatment, she was haltered and led into a room, where she stood in a set of stocks that prevented her from moving to the side. Her head was held in a stanchion. After she was in the stanchion, she was provided with hay to eat. Electrode leads were attached to each stainless steel suture with small alligator clips. The cows displayed no visible reaction to the clips being attached to the sutures. A battery-powered transmitter telemetrically relayed the heart beats to a receiver controlled by a microcomputer, which recorded each beat and tabulated a per-minute rate using a modification of Datacol (Stuart and Friend, 1989). Heart rate was monitored every 3 min to determine when the cow's heart rate returned to baseline. When the cow's heart rate was within a 5-beat/min range for three samples, the sampling procedure commenced.

Hot-iron-branded cattle were branded with a brand of the letter 'T' 8.75 cm high on the left hindquarter using a conventional electric brander (L&H Mfg., Mandan, ND) at approximately 521°C for 5 s. The freeze-branded group was branded on the left hindquarter immediately after a liberal amount of 95% methanol had been applied. The copper/bronze freeze brander (L&H Mfg., Mandan, ND) was the letter "T" 8.75 cm high with a .96-cm rounded face. Liquid nitrogen was used as the coolant and the brander was applied for 18 s, as recommended by Kirkeide and Johnson (1982).

The cow's behavioral reactions to branding were noted and the occurrence of kicking during branding was recorded for each individual.

Ten-milliliter blood samples were drawn into syringes containing .1 mL of a 10% Na-EDTA solution. Samples were taken at -2.5, -5, .5, 1, 1.5, 3.5, 5.5, 10.5, 15.5, and 25.5 min relative to branding. Blood samples were placed in an ice bath and centrifuged at 0 to 5°C within 2 h of sampling. The plasma was frozen at -25°C to prevent catecholamine degradation (Goldstein, 1986).

Cortisol concentrations were determined on duplicate samples using commercially available coated-tube RIA Kits (Pantex, Santa Monica, CA). Samples were re assayed if the duplicates differed by more than 5%. The intraassay CV for cortisol was 10.2%. Crossreactivity of the antiserum was as follows: cortisol, 100%; prednisolone, 40%; 11-desoxycortisol, 13.3%; and corticosterone, 10.5%. Cortisone, prednisone, and dexamethasone were < 3.1% (analysis by Pantex).

Catecholamine concentrations were determined by HPLC with electrochemical detection. The procedure described by Champney et al. (1985) was modified by using 500 µL of .4 M HClO4 with .5 g of Na2EDTA and 1 g of Na2S2O5/L to acidify and deproteinize the plasma and prevent catecholamine oxidation (Rulofson et al., 1988). The tubes were then centrifuged for 5 min and the liquid portion decanted into 2-mL microcentrifuge tubes for extraction. The recovery of standards after extraction was 76% and the intraassay CV for NOR and EPI were 2.8 and 8.5%, respectively. The least detectable concentration was .30 ng/mL.

Heart rate, cortisol, EPI, and NOR data were analyzed using the GLM procedure of SAS (1985). Time (am vs pm) and day (d 1 to 4) were originally included in the model but due to nonsignificance were excluded in the final model. A split-plot model was used with breed, treatment, breed x treatment, animal (breed x treatment) as the main plot, with breed, treatment, and breed x treatment tested with the animal (breed x treatment) error. The subplot consisted of sample number (i.e., time relative to branding), breed x sample number, treatment x sample number, breed x treatment x sample number, and sample number x animal.
Effects of Branding on Cattle

Incidental observations indicated that the F cows reacted to branding by lowering their backs and shifting their weight between their two hind feet. The H cows reacted by immediately jumping away from the iron and usually by kicking. The S cows did not react to the room-temperature branding iron. The kicking reaction (directed toward the person holding the brander) of the cows (whether a cow kicked or not) and associated probabilities were as follows: H, seven kicks with $P = .002$, F, one kick with $P = .15$, and S, zero kicks with $P = .04$. These data indicate that H cows reacted to treatments more adversely than did F or S cows. None of the 24 cows vocalized during branding.

The heart rates (HR) of both the F and H cows increased during branding ($P = .0001$), but the HR of the H cows returned to base levels at 5.5 min postbranding, whereas the HR of the F cows remained slightly elevated throughout the 25-min monitoring period ($P = .05$, Figure 1). When heart rate was analyzed as a proportion of the prebranding mean (HR-P), data showed that H cows had higher HR-P than F and S cows during branding ($P = .04$) and that F cows had higher HR-P than S cows ($P = .0004$). The HR-P at the remaining sample times were similar to mean heart rate analysis (Figure 1). Both F and H cows had higher HR-P at .5 and 1 min after branding than did S cows ($P = .04$). At 15.5 min postbranding, F cows had greater HR-P than either H or S cows ($P = .07$).

Plasma cortisol concentrations were consistently greater for both the F and H cows than for the S cows beginning at 5.5 min after branding (Figure 2, $P = .04$). This is consistent with the nature of cortisol, which takes more time than catecholamines to be released in response to a stressor (Alam and Dobson, 1988). When cortisol was analyzed as a proportion of the prebranding mean (C-P), data indicated that H cows exhibited higher mean C-P than either S or F cows at $10.5$ ($P = .08$), $15.5$ ($P = .04$), and $25.5$ ($P = .02$) min after branding.

Concentrations of epinephrine and norepinephrine did not show overall trends in response to treatments. The mean EPI concentrations over the sampling procedure were $0.54$ ng/mL ± $0.04$ (S), $0.49$ ng/mL ± $0.04$ (H), and $0.44$ ng/mL ± $0.04$ (F). The mean NOR concentrations over the sampling procedure were $1.36$ ng/mL ± $0.16$ (S), $1.25$ ng/mL ± $0.11$ (H), and $1.09$ ng/mL ± $0.10$ (F). When EPI was analyzed as a proportion of the prebranding mean
(EPI-P), F cows had greater EPI-P than the S cows (P = .03) but not greater EPI-P than the H cows at 1 min postbranding. Freeze-branded cows had higher NOR proportions (NOR-P) at .5 in postbranding than H and S cows (P = .005). At 1 and 1.5 min postbranding, F cows tended to have higher NOR-P than either H or S cows (P = .09).

Discussion

Because humans and other mammals react to pain with an avoidance reaction (Vycklycky, 1984), the greater adverse reaction of H cows than of F or S cows to branding is interpreted to indicate a greater pain perception by these animals. Vocalizations are another behavioral sign of distress and pain (Dennis and Melzack, 1983; Morton and Griffiths, 1985); however, none of the 24 cows vocalized during treatments. Previous branding research (Lay et al., 1992a,b) has found varied results when measuring vocalizations. As one prior study suggested (Lay et al., 1992b), the lack of vocalizations in this study could have been caused by the cow's isolation from its herdmates during branding.

Elevated heart rates also have been associated with greater pain sensations (Pratt, 1980; Morton and Griffiths, 1985). The prolonged elevated heart rates of F cows compared with those of H cows may indicate a sensation of greater duration for F cows than for H cows, possibly due to the thawing of the brand site. The greater HR-P of the H cows during branding also coincided with the more aversive behavior that the H cows exhibited during branding.

By using tame dairy cows that were accustomed to handling and retrained the elevation of stress responses normally associated with these events was minimized. In two similar branding studies conducted in this laboratory, untamed Bradford crossbred cattle (Lay et al., 1992b) and untamed Angus cattle (Lay et al., 1992a) were used to determine the response of these breeds to freeze and hot-iron branding. In both of those studies, restraint significantly increased plasma cortisol concentrations for all three treatments during the 25-min sampling period, and caused the cows to have elevated heart rates before application of the treatments.

Mean EPI and NOR concentrations were low compared with those of different breeds (Lay et al., 1992a,b) but were consistent with those found for dairy cows (Lefcourt et al., 1986). Because NOR and EPI concentrations were low in our research, caution should be taken in interpreting these data because they approached the least detectable level for the assay. The lack of a significant EPI response for H cows at .5 min postbranding contrasts with previous branding research (Lay et al., 1992a,b) that found elevated EPI, which in humans has been found to be increased in response to pain perception and psychological stress (Frankenhaeuser, 1975; Goldstein et al., 1983). In one study (Lefcourt et al., 1986), in which dairy cows were electrically shocked at increasing intensities, no EPI or NOR responses were found. The docility that has been selected for in the dairy cattle breeds may have resulted in a decreased ability to respond to certain stressors with a catecholamine release.

People who raise cattle are largely against changing from hot-iron branding to freeze branding even though hot-iron branding decreases the value of the hide (Fitzgerald, 1989). Much of this stems from an unwillingness to forsake tradition, but also freeze brands are not immediately visible on the animal and are not clearly visible on hides after hair removal, it is more time-consuming to freeze brand, and the cost of liquid nitrogen or dry ice, as well as the difficulty of procuring them, make freeze branding more expensive and sometimes impractical.

No simple relationship exists between a noxious stimulus and pain perception, due to the influence of past experience, current emotional state, and possible innate individual differences (Kitchen et al., 1987). However, by quantifying accepted measures of pain and distress we can compare different management techniques. This study has shown that freeze branding produced a prolonged heart rate response, possibly due to the thawing process of the wound. Hot-iron branding produced a stronger, acute HR-P, elevated C-P, and a strong aversive behavioral reaction indicative of pain.

Implications

People who raise cattle can not always choose between hot-iron branding and freeze branding because freeze branding is not immediately visible and it requires local availability and a storage capability for liquid nitrogen or dry ice. Although not painless, freeze branding is a method of identifying cattle that causes less short-term pain reaction than does hot-iron branding.

Literature Cited


