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Evaluation of pain and stress mitigation strategies during thermal disbudding in Jersey crossbred calves

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Abstract

The present study evaluated the efficacy of different analgesic protocols for alleviating pain and stress associated with thermal disbudding in Jersey crossbred calves. 9 Jersey crossbred calves aged 4 - 6 weeks were randomly allocated to three groups (n = 3 each): Treatment Group 1 (TG 1), Treatment Group 2 (TG 2), and Treatment Group 3 (TG 3). All calves underwent hot-iron disbudding following administration of 2% lignocaine hydrochloride. In addition, calves in TG2 and TG3 received meloxicam, a short-acting Non-Steroidal Anti-Inflammatory Drug (NSAID), and tolfenamic acid, a long-acting NSAID, respectively. Pain- and stress-related behavioural, physiological, and production parameters were assessed during the first 4 hours, over 3 days, and for 1 month following disbudding, respectively. During the disbudding procedure, calves in TG1 showed a higher frequency of pain-related behaviours, including bellowing, ear rubbing, struggling, kicking, urination, and defecation, compared with calves receiving meloxicam or tolfenamic acid. Among the physiological parameters, heart rate was significantly reduced on the second and third days following disbudding, whereas the other parameters did not differ significantly among the groups. Notably, calves treated with meloxicam and tolfenamic acid exhibited greater body weight gain than those in TG 1. The findings indicate that the incorporation of NSAIDs, particularly meloxicam and tolfenamic acid, alongside local anaesthesia, can effectively reduce pain- and stress-associated responses during and after thermal disbudding. These analgesic protocols may therefore contribute significantly to improving calf welfare and promoting more humane disbudding practices in dairy production systems.

Keywords: Crossbred calves, disbudding, mitigation, pain, thermal and stress

Introduction

Disbudding refers to the removal or destruction of the horn bud and horn-producing cells before they attach to the periosteum of the frontal bone. Generally, disbudding is carried out before the calf reaches 3 months of age. The objective of disbudding or dehorning is to enhance the mental and physical comfort of the animals and improve worker safety (Gottardo *et al.*, 2011). The reasons for performing disbudding include a decreased risk of fights and animal injuries, increased staff and labor safety, and reduced floor space allowance for animals. Commonly, disbudding is performed using surgical, chemical, or thermal methods. Thermal disbudding using hot iron or cauterization is widely followed worldwide, but it can cause pain and stress at any age in cattle (Stafford and Mellor, 2005) and also causes third-degree burns where the hot iron is applied and first and second-degree burns on the surrounding tissue of the horn buds (Adcock and Tucker, 2018). Pain management for disbudding or dehorning of cattle is a significant animal welfare issue in the dairy industry (Ventura *et al.*, 2015). The painful procedure of disbudding can lead to changes in behavior, physiological parameters, and increased secretion of stress hormones (Stewart *et al.*, 2008). Numerous studies (Duffield *et al.*, 2010; Stilwell *et al.*, 2012; Huber *et al.*, 2013 and Stock *et al.*, 2015) have reported that the combined application of anesthetic and analgesic agents (Non-Steroidal Anti-Inflammatory Drugs, such as ketoprofen, meloxicam, carprofen, flunixin, and firocoxib) during or after disbudding/dehorning alleviates pain and stress and promotes animal welfare. Hence, the NSAID is the most powerful pain-relieving compound in many species of animals. Therefore, this present study aims to document the effectiveness of using

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short-acting (meloxicam) and long-acting (tolfenamic acid) Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) as a strategy for pain and stress management. Additionally, it also explores their role in augmenting animal welfare during and after thermal disbudding in Jersey crossbred calves.

Materials and methods

The present study was carried out at the Cattle and Buffalo Breeding Unit (CBBU), Livestock Research Station (LRS), TANUVAS, Kattupakkam, Chengalpattu district, Tamil Nadu, India. Nine numbers of day-old weaned Jersey crossbred calves were selected based on their age (4 to 6 weeks) and body weight (35 to 40 kg). The calves were maintained under an intensive system and fed milk at the rate of 15% of their body weight, calf starter at 100 g daily, and had ad-libitum access to fresh drinking water. The selected calves were randomly divided into three groups (Treatment Groups 1, 2 and 3) with three calves in each group.

All the calves in each group (TG 1, 2 and 3) have undergone hot-iron disbudding using an electrical dehorner (approximately 500°C) with a 2% lignocaine hydrochloride injection of 4 ml on each side for a cornual nerve block (Fig. 1), administered 10 minutes prior to the procedure. Furthermore, the calves in TG 2 were administered the short-acting NSAID Inj. Meloxicam intramuscularly (I/M) for three consecutive days (10 minutes prior to disbudding, 2nd day and 3rd day) at a dosage of 0.5 mg/kg body weight, whereas the calves in TG 3 were administered the long-acting NSAID Inj. Tolfenamic Acid (TA) intramuscularly (I/M) with a single dose of 2 mg/kg body weight ten minutes prior to the procedure. The reason for selecting these two NSAIDs is their analgesic, antipyretic, and anti-inflammatory properties, along with their good therapeutic response in veterinary medicine (Lees *et al.*, 2004). The pain and stress indicators of behavioral parameters suggested by Herskin and Nielsen (2018) and Graf and Senn (1999) were physically observed for during and after 4 hours of the disbudding procedure. The indicators' behavioral parameters were listed in table 1. In this table, the symbol "×" indicates the particular behavioral sign present in a calf, and the symbol "-" indicates the mentioned behavioral sign not present in a calf during the physically observed period. Similarly, physiological parameters (rectal temperature, respiration rate, heart rate, and pulse rate) were monitored manually once, 10 minutes before the procedure, and followed for 10 minutes after the procedure and the next two consecutive days. The average physiological parameters recorded 10 minutes prior were considered as control parameters in all the experimental groups for calculation and comparison purposes. The production parameter such as body weight gain was recorded at fortnightly intervals for a month in all the treatment group calves. Immediately after disbudding, the povidone iodine antiseptic ointment was applied to the horn buds removed in and around the area for all the experimental calves. It was preventing fly annoyance and enhancing the wound healing process. The data on physiological and production parameters was analyzed using descriptive statistics on the Dunn-Bonferroni post-hoc test using GraphPad Prism statistical software (version 5.03).

Results and discussion

Behavioral indicators of pain and stress

The presence and absence of behavioral indicators of pain and stress during disbudding and after 4 hours associated with thermal disbudding are shown in Table 1. Among the treatment groups, during the disbudding procedure, TG 1

calves exhibited more behavior disturbances like bellowing, head rubbing, struggling, kicking, urination and defecation. Whereas TG 2 was exhibited with a head shake and ear flick and TG 3 was exhibited with head shake and head rub, respectively. The results revealed that TG 1 calves experienced the highest frequency of behavioral disturbances related to pain and stress during the disbudding procedure, compare to TG 2 and TG 3 calves.

Similarly, after 4 hours of the post-operative disbudding procedure, TG 1 alone exhibited behavioral changes in posture, continuous standing, grooming, self-grooming, and tears in eyes. Due to scratching the head on the wall, the disbudding wound was further aggravated in TG 1 calves. Positive behavioral responses, viz., calf lying, rumination, feeding and drinking, were comparatively higher in TG 2 and TG 3 groups. The results revealed that the NSAID-administered calves (TG 2 and TG 3) effectively mitigated the pain and stress as compared to non-NSAID administered calves (TG 1). The results from the present study are in agreement with the finding that 2% lignocaine hydrochloride, along with short-acting meloxicam administered for three days and a single dose of long-acting tolfenamic acid, effectively mitigated pain and stress during and after the four-hour disbudding period. Similar to this finding, Faulkner and Weary (2000) found that the NSAID drug ketoprofen has reduced the pain after hot-iron dehorning in Holstein calves. Heinrich *et al.* (2010) also reported that the combination of lidocaine and meloxicam has effectively reduced ear flick and head shake during cautery dehorning. McMeekan *et al.* (1998) also found that providing animals with NSAIDs significantly reduced the normally observed increase in plasma cortisol during electrical dehorning. The NSAID is considered to bind preferentially to cyclooxygenase-2 (COX-2) to inhibit prostaglandin synthesis and reduce the pain in the calf.

Physiological indicators of pain and stress

The effect of thermal disbudding on Jersey crossbred calves on physiological indicators viz., rectal temperature (R/T), heart rate (H/R), respiration rate (R/R), and pulse rate (P/R) before disbudding (Control - C) and after disbudding for three consecutive days is furnished in the table.2. Immediately after disbudding, the R/T, H/R, R/R, and P/R were increased but not significantly. The H/R of all the treatment groups was significantly ($P \leq 0.01$) changed with the control parameter on the 1st, 2nd and 3rd days of post-disbudding period. It is justified that heart rate may increase due to pain and stress during post-operative period. The TG 2 and TG 3 physiological parameters were lower than the TG 1 during the post- disbudding period. It shows NSAID groups were mitigating the pain and stress after thermal disbudding. Heinrich *et al.* (2009) and Stewart *et al.* (2009) reported similar findings on that the NSAID meloxicam was reducing the stress response seen in heart rate and respiration rate during the period of dehorning. Recently, Bacon *et al.* (2025) reported organic dairy producers should continue to use an effective local anesthetic at a minimum to mitigate disbudding pain and treat unregulated and untested herbal remedies with caution.

Production indicators of pain and stress

The disbudding effect on production indicators was assessed through their body weight and average daily gain in Jersey crossbred calves, as shown in the table.3. The body weight and average daily gain were calculated fortnightly up to one

month post-operative period. The body weight was 37.50 ± 2.18 on 0th day and 39.33 ± 3.35 on 30th day post disbudding in TG 1 group. The body weight was 37.67 ± 1.89 and 37.67 ± 1.26 at the day of disbudding and 41.67 ± 2.32 and 41.80 ± 2.13 at the 30th day of post-disbudding in the TG 2 and TG 3 groups, respectively. Table 3 showed that the body weight continuously increased in all the experimental calves; TG 2 and TG 3 groups' body weight was higher than the TG 1 group at the 15th and 30th days of the post-operative period. The weight gain of one month post-disbudding period was also higher in TG 2 and TG 3 groups than in the TG 1 group,

but not significantly. It indicated that the NSAID groups' (TG 2 and TG 3) body weight and weight gain were higher than the 2% lignocaine hydrochloride alone (TG1) group. Bates *et al.* (2015) contrary found no effect on the growth rate of analgesia and anti-inflammatory treatment disbudding calves. The body weight and weight gain of the TG 3 group at 30 days post-disbudding period were higher than those of the TG 2 group. It specified that the long-acting NSAID group (TG 3) effectively increased the body weight and weight gain as compared to short-acting NSAID group (TG 2).

Table 1: Effect of thermal disbudding on Jersey crossbred calves behavioral indicators

S.no	Behavioral indicators	TG 1	TG 2	TG 3
I. At the time of disbudding				
1.	Bellowing	x--	---	---
2.	Head shake	---	-x-	x--
3.	Head rubbing	x-x	---	-x-
4.	Ear flick	---	x--	---
5.	Struggling	xx-	---	---
6.	Kicking	--x	---	---
7.	Escape attempt	---	---	---
8.	Urination	x--	---	---
9.	Defecation	x--	---	---
10.	Tail flick	---	---	---
II. 4 hours post-operative period				
1.	Postural changes	x--	---	---
2.	Falling	---	---	---
3.	Continuous standing	-x-	---	---
4.	Lying	x-x	xxx	xxx
5.	Grooming (against the wall)	-x-	x--	x--
6.	Self-grooming	-x-	---	---
7.	Rumination	x-x	xxx	xxx
8.	Tear in the eyes	--x	---	---
9.	Feeding	x-x	xxx	xxx
10.	Drinking	x-x	xxx	xxx

Symbol "x" indicate the particular behavioral sign present in a calf; Symbol "-" indicate the particular behavioral sign not

present in a calf during the physically observed period

Table 2: Effect of thermal disbudding on physiological indicators in Jersey crossbred calves

-	TG 1				TG 2				TG 3			
	R/T	H/R	R/R	P/R	R/T	H/R	R/R	P/R	R/T	H/R	R/R	P/R
C	38.8 ±0.1	90.9 ±2.6	33.1 ±2.8	96.6 ±1.7	38.8 ±0.1	90.9 ±2.6	33.1 ±2.8	96.6 ±1.7	38.8 ±0.1	90.9 ±2.6	33.1 ±2.8	96.6 ±1.7
1 st day	39.5 ±0.1	116.7** ±3.2	39.1 ±0.7	103.0±1.2	39.5 ±0.2	102.5** ±1.7	34.0 ±0.1	97.0 ±1.4	39.0 ±0.1	101.0** ±0.9	35.1 ±1.1	96.7 ±1.2
2 nd day	39.0 ±0.2	105.7**±4.7	37.2 ±0.1	100.7±1.4	39.1 ±0.1	101.3** ±2.1	29.0 ±0.8	99.6 ±0.9	39.0 ±0.1	101.3** ±2.0	33.7 ±1.8	97.8 ±0.9
3 rd day	39.6 ±0.2	107.0**±3.4	33.7 ±1.1	104.0±1.6	39.0 ±0.1	99.3** ±1.0	29.3 ±0.8	98.3 ±1.3	39.2 ±0.2	103.7** ±1.9	29.0 ±1.8	100.4 ±1.2

**Highly significant ($P \leq 0.01$)

Table. 3: Comparative analysis of physiological indicators between control and treatment groups following thermal disbudding in Jersey crossbred calves

Physiological Indicators	Timeline	TG 1 vs Control	TG 2 vs Control	TG 3 vs Control
i. Temperature	Day 1	t = 0.3139 P > 0.05 (ns)	t = 0.3893 P > 0.05 (ns)	t = 0.1169 P > 0.05 (ns)
	Day 2	t = 0.1318 P > 0.05 (ns)	t = 0.1529 P > 0.05 (ns)	t = 0.08806 P > 0.05 (ns)
	Day 3	t = 0.3402 P > 0.05 (ns)	t = 0.1244 P > 0.05 (ns)	t = 0.1969 P > 0.05 (ns)
ii. Heart Rate	Day 1	t = 9.694 P < 0.01 (**)	t = 6.178 P < 0.01 (**)	t = 4.853 P < 0.01 (**)
	Day 2	t = 5.740 P < 0.01 (**)	t = 5.539 P < 0.01 (**)	t = 5.005 P < 0.01 (**)
	Day 3	t = 6.219 P < 0.01 (**)	t = 4.495 P < 0.01 (**)	t = 6.132 P < 0.01 (**)
iii. Respiratory Rate	Day 1	t = 0.9057 P > 0.05 (ns)	t = 0.5866 P > 0.05 (ns)	t = 0.9446 P > 0.05 (ns)
	Day 2	t = 0.2132 P > 0.05 (ns)	t = 2.172 P > 0.05 (ns)	t = 0.2722 P > 0.05 (ns)
	Day 3	t = 1.061 P > 0.05 (ns)	t = 2.007 P > 0.05 (ns)	t = 1.953 P > 0.05 (ns)
iv. Pulse Rate	Day 1	t = 1.566 P > 0.05 (ns)	t = 0.2506 P > 0.05 (ns)	t = 0.06244 P > 0.05 (ns)
	Day 2	t = 0.7296 P > 0.05 (ns)	t = 1.660 P > 0.05 (ns)	t = 0.6084 P > 0.05 (ns)
	Day 3	t = 1.928 P > 0.05 (ns)	t = 0.9421 P > 0.05 (ns)	t = 1.848 P > 0.05 (ns)

ns - Non Significant ($P > 0.05$)

** - Highly significant ($P \leq 0.01$)

Table 4: The effect of disbudding on body weight (kg) and body weight gain (kg) in Jersey crossbred calves

Post disbudding	Body weight (Mean $\pm$ SD) at fortnight Interval (kg)			Post disbudding (Days)	Wight gain (Mean $\pm$ SD) during 15 days period (kg)		
	TG 1	TG 2	TG 3		TG 1	TG 2	TG 3
0 th day	37.50 $\pm$ 2.18	37.67 $\pm$ 1.89	37.67 $\pm$ 1.26	0 th - 15 th	0.50 $\pm$ 0.56	1.66 $\pm$ 0.42	1.83 $\pm$ 0.29
15 th day	38.00 $\pm$ 3.50	39.33 $\pm$ 2.25	39.50 $\pm$ 1.80	16 th - 30 th	1.33 $\pm$ 0.27	2.34 $\pm$ 0.40	2.30 $\pm$ 0.87
30 th day	39.33 $\pm$ 3.35	41.67 $\pm$ 2.32	41.80 $\pm$ 2.13	-			

Conclusion

Based on the behavioral, physiological, and production indicators of calves, it was shown that the short-acting and long-acting NSAIDs may effectively mitigate the pain and stress during and after the disbudding period. This is also a key to augmenting animal welfare in the dairy industry.

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