Full Length Article

PAIN AND STRESS MANAGEMENT OF JERSEY CROSSBRED CALVES DURING THERMAL DISBUDDING

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ABSTRACT

The aim of disbudding is to enhance the physical comfort of animals and improve handler safety. Reducing pain during and after the procedure is a critical animal welfare concern in dairy production. Nine Jersey crossbred calves, aged 4 to 6 weeks, were randomly assigned to three treatment groups (n = 3per group): Group 1 (TG1), Group 2 (TG2), and Group 3 (TG3). All calves underwent hot-iron disbudding under local anesthesia (2% lignocaine hydrochloride). In addition, TG2 and TG3 received Meloxicam (a short-acting NSAID) and Tolfenamic acid (a long-acting NSAID), respectively. Pain and stress indicators, including behavioral, physiological, and production parameters, were monitored over 4 hours, 3 days, and one month. During the disbudding period, TG1 calves exhibited significantly more frequent behavioral pain indicators such as bellowing, head rubbing, struggling, and kicking compared to TG2 and TG3. Regarding physiological indicators, heart rates on the 2nd and 3rd days post-disbudding were significantly lower in the NSAID treated groups, while other physiological parameters showed no significant changes. Although body weight gain was higher in TG2 (1.66 ± 0.42 kg) and TG3 (1.83 ± 0.29kg) than in TG1 (1.83 ± 0.29 kg), these differences were not statistically significant (P > 0.05). It is concluded that the administration of either short-acting (Meloxicam) or long-acting (Tolfenamic acid) NSAIDs is an effective approach for mitigating pain and stress in calves during and after thermal disbudding. Implementing such protocols is essential for advancing animal welfare standards in the dairy industry.

Keywords: Disbudding, Management, Jersey, Pain, Stress and Thermal

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INTRODUCTION

Disbudding refers to the removal or destruction of the horn bud and its associated horn-producing cells before they attach to the periosteum of the frontal bone. Generally, this procedure is carried out before a calf reaches three months of age. The primary objective of disbudding or dehorning is to enhance the physical and psychological comfort of the animals while simultaneously

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improving worker safety (Gottardo *et al.*, 2011). The rationale for disbudding includes a decreased risk of social aggression and subsequent animal injuries, increased safety for farm labor, and a reduction in the floor space required for housing.

Commonly, disbudding is performed using surgical, chemical, or thermal methods. Thermal disbudding, which utilizes a hot iron or cauterization, is the most widely practiced method globally; however, it induces significant pain and stress in cattle regardless of age (Stafford and Mellor, 2005). Furthermore, the application of a hot iron results in third-degree burns at the site of contact, alongside first- and second-degree burns on the surrounding tissue of the horn buds (Adcock and Tucker, 2018).

Consequently, pain management during the disbudding or dehorning of cattle has become a critical animal welfare issue within the dairy industry (Ventura *et al.*, 2015). This painful procedure often leads to adverse changes in behavior and physiological parameters, as well as an increased secretion of stress hormones (Stewart *et al.*, 2008). Numerous studies (Duffield *et al.*, 2010; Stilwell *et al.*, 2012; Huber *et al.*, 2013; Stock et al., 2015) have demonstrated that the combined application of anesthetic and analgesic agents specifically Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) such as ketoprofen, meloxicam, carprofen, flunixin, and firocoxib during or after the procedure effectively alleviates pain and stress, thereby promoting animal welfare.

NSAIDs are recognized as highly effective pain-relieving compounds across various animal species. Therefore, the present study aims to document the efficacy of using short-acting (meloxicam) and long-acting (tolfenamic acid) NSAIDs as a strategy for pain and stress management. Additionally, this research explores the role of these treatments in augmenting animal welfare during and after thermal disbudding in Jersey crossbred calves.

MATERIALS AND METHODS

Study Site and Animals

The study was conducted at the Cattle and Buffalo Breeding Unit (CBBU), Livestock Research Station (LRS), TANUVAS, Kattupakkam, Tamil Nadu, India. Nine Jersey crossbred calves were selected based on age (4 to 6 weeks) and body weight (35 to 40 kg). The calves were maintained under an intensive management system and fed milk at 15% of their body weight, supplemented with 100 g of calf starter daily and provided ad-libitum access to fresh water.

Experimental Design and Ethical Justification

The calves were randomly assigned to three treatment groups (TG1, TG2, and TG3), with three calves per group (n=3). This sample size is ethically justified under the principle of Reduction (3Rs) to minimize the number of animals subjected to a painful procedure. To mitigate the limitations of a small sample size, a longitudinal repeated-measures design was implemented. Baseline data were collected for each animal prior to treatment, allowing each calf to serve as its own internal control. This approach effectively controlled for between-subject biological variation, significantly increasing the statistical power of the trial.

Treatment Protocols

All calves underwent hot-iron disbudding using an electrical dehorner (approx. 500°C). A cornual nerve block was achieved using 4 ml of 2% lignocaine hydrochloride on each side, administered 10 minutes prior to the procedure.

- **Control (C):** 10 minutes before the procedure to serve as the baseline control data.
- **TG1:** Received only local anesthesia (2% lignocaine hydrochloride).
- **TG2:** Received short-acting Meloxicam (0.5 mg/kg BW, I/M) for three consecutive days (10 minutes pre-procedure, and on days 2 and 3).
- **TG3:** Received a single dose of long-acting Tolfenamic acid (2 mg/kg BW, I/M) 10 minutes prior to the procedure.

These NSAIDs were chosen for their analgesic and anti-inflammatory properties and proven therapeutic response in veterinary medicine (Lees *et al*., 2004).

Observations

Behavioral indicators of pain (Table 1) were physically observed during the procedure and for four hours post-disbudding (Herskin and Nielsen, 2018; Graf and Senn, 1999). In Table 1, the symbol "☑" indicates the presence of a behavioral sign, and "☒" indicates its absence. Physiological parameters (rectal temperature, respiration rate, heart rate, and pulse rate) were recorded 10 minutes before the procedure (baseline control), 10 minutes after, and once daily for the following two consecutive days. Production parameters, specifically body weight gain, were recorded at fortnightly intervals for one month.

Statistical Analysis

Data were analyzed using descriptive statistics. To determine significance between treatment groups, a One-way ANOVA was performed, followed by the Dunn-Bonferroni post-hoc test for multiple comparisons using Graph Pad Prism (version 5.03). Statistical significance was defined at $P < 0.05$ and $P < 0.01$.

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, TG1 calves exhibited more behavior disturbances like bellowing, head rubbing, struggling, kicking, urination and defecation. Whereas TG2 was exhibited with a head shake and ear flick and TG3 was exhibited with head shake and head rub, respectively. The results revealed that TG1 calves experienced the highest frequency of behavioral disturbances related to pain and stress during the disbudding procedure, compare to TG2 and TG3 calves.

Similarly, after 4 hours of the post-operative disbudding procedure, TG1 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 TG1 calves. Positive behavioral responses, viz., calf lying, rumination, feeding and drinking, were comparatively higher in TG2 and TG3 groups.The results revealed that the NSAID - administered calves (TG2 and TG3) effectively mitigated the pain and stress as compared to non-NSAID administered calves (TG1).

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 table2 and 3. 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 TG2 and TG3 physiological parameters were lower than the TG1 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 4. 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 TG1 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 TG2 and TG3 groups, respectively.

Table 4 showed that the body weight continuously increased in all the experimental calves; TG2 and TG3 groups' body weight was higher than the TG1 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 TG2 and TG3 groups than in the TG1 group, but not significantly. It indicated that the NSAID groups' (TG2 and TG3) 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 TG3 group at 30 days post-disbudding period were higher than those of the TG2 group. It specified that the long-acting NSAID group (TG3) effectively increased the body weight and weight gain as compared to short-acting NSAID group (TG2).

CONCLUSION

Based on behavioral, physiological, and production indicators, the administration of short-acting (Meloxicam) or long-acting (Tolfenamic acid) NSAIDs effectively mitigates pain and stress associated with thermal disbudding in Jersey crossbred calves. Incorporating these analgesics into standard disbudding protocols is a vital strategy for augmenting animal welfare standards within the dairy industry.

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CONFLICT OF INTEREST

No conflict of interest.

Table1: Effect of thermal disbudding on Jersey crossbred calves behavioral indicators

S.no	Behavioral indicators	TG1	TG2	TG3
I. At the time of disbudding				
1.	Bellowing	☑☒☒	☒☒☒	☒☒☒
2.	Head shake	☒☒☒	☒☑☒	☑☒☒
3.	Head rubbing	☑☒☑	☒☒☒	☒☑☒
4.	Ear flick	☒☒☒	☑☒☒	☒☒☒
5.	Struggling	☑☑☒	☒☒☒	☒☒☒
6.	Kicking	☒☒☑	☒☒☒	☒☒☒
7.	Escape attempt	☒☒☒	☒☒☒	☒☒☒
8.	Urination	☑☒☒	☒☒☒	☒☒☒
9.	Defecation	☑☒☒	☒☒☒	☒☒☒
10.	Tail flick	☒☒☒	☒☒☒	☒☒☒
II. 4 hours post-operative period				
1.	Postural changes	☑☒☒	☒☒☒	☒☒☒
2.	Falling	☒☒☒	☒☒☒	☒☒☒
3.	Continuous standing	☒☑☒	☒☒☒	☒☒☒
4.	Lying	☒☑☒	☑☑☑	☑☑☑
5.	Grooming (against the wall)	☒☑☒	☑☒☒	☑☒☒
6.	Self-grooming	☒☑☒	☒☒☒	☒☒☒
7.	Rumination	☒☑☒	☑☑☑	☑☑☑
8.	Tear in the eyes	☒☒☑	☒☒☒	☒☒☒
9.	Feeding	☒☑☒	☑☑☑	☑☑☑
10.	Drinking	☒☑☒	☑☑☑	☑☑☑

Symbol "☑" 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

Table2: Effect of thermal disbudding on physiological indicators in Jersey crossbred calves

-	TG1				TG2				TG3			
	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
1st day	39.5 ±0.1	116.7** ±3.2	39.1 ±0.7	103.0 ±1.2	39.5 ±0.1	102.5** ±21.7	34.0 ±0.1	97.0 ±1.4	39.0 ±0.1	101.0** ±0.9	35.1 ±1.1	96.7 ±1.2
2nd 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
3rd 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

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

Physiological Indicators	Timeline	TG1 vs Control	TG2 vs Control	TG3 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≤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 ± SD) at fortnight Interval (kg)			Post disbudding (Days)	Wight gain (Mean ± SD) during 15 days period (kg)		
	TG1	TG2	TG3		TG1	TG2	TG3
0^{th} day	37.50 ± 2.18	37.67 ± 1.89	37.67 ± 1.26	0^{th} - 15^{th}	0.50 ± 0.56	1.66 ± 0.42	1.83 ± 0.29
15^{th} day	38.00 ± 3.50	39.33 ± 2.25	39.50 ± 1.80	16^{th} - 30^{th}	1.33 ± 0.27	2.34 ± 0.40	2.30 ± 0.87
30^{th} day	39.33 ± 3.35	41.67 ± 2.32	41.80 ± 2.13	-			

Cornual nerve block

Disbudding process

Horn buds removed calf

Fig 1: Hot-iron disbudding under 2% lignocaine hydrochloride in Jersey crossbred calf

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