

1 **Innovative Approaches to Castration Pain Management**

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7 **Abstract**

8 Castration is a routine painful management procedure in cattle, significantly impacting animal  
9 welfare. At Kansas State University, innovative approaches to pain management during  
10 castration, including the use of lidocaine-infused bands, maternal bovine appeasing substance  
11 (MBAS), and castration clips were evaluated. Our preliminary findings indicate potential  
12 benefits in using these methods to improve comfort and performance in calves, highlighting the  
13 importance of developing practical and effective pain mitigation strategies. These advancements  
14 represent critical steps toward enhancing the welfare of cattle undergoing painful management  
15 procedures. Nevertheless, further research is needed to continue the advancement of pain  
16 mitigation in livestock species.

17 **Innovative Approaches to Castration Pain Management**

18 Pain is defined by the International Association for the Study of Pain as “an unpleasant sensory  
19 and emotional experience associated with, or resembling that associated with, actual or potential  
20 tissue damage” (IASP, 1979; Raja et al., 2020). Humans can articulate their pain verbally,  
21 specifying its location and intensity, while animals cannot. Thus, Molony and Kent (1997)  
22 defined animal pain as “an aversive sensory and emotional experience representing awareness by

23 the animal of damage or threat to the integrity of its tissues; it changes the animal's physiology  
24 and behaviour to reduce or avoid the damage, to reduce the likelihood of recurrence, and to  
25 promote recovery." Both definitions emphasize the emotional aspect of pain, which also has  
26 incapacitating effects that can compromise survival by impairing the ability to acquire food,  
27 water, and shelter. Pain can further affect physical health, causing metabolic changes that  
28 interfere with wound healing and lead to immunosuppression, making animals more susceptible  
29 to secondary diseases.

### 30 **Pain and Welfare**

31 The definition of animal welfare has evolved significantly in the past 25 years (Molony, 2015).  
32 A widely accepted definition states that "animal welfare is defined as how an animal is coping  
33 with the conditions in which it lives" (Broom, 1986). Modern frameworks also emphasize the  
34 importance of animal affective, or mental, states, reflecting how the animal feels. Increasing  
35 welfare value now involves not just reducing negative, but also enhancing positive affective  
36 states, reinforcing the idea that animals should have "a life worth living" (Mellor, 2015; Green  
37 and Mellor, 2011). The sensory discomfort of pain significantly reduces animal welfare by  
38 negatively impacting their mental state. However, pain is complex, and no single measure can  
39 fully capture the breadth of this negative sensory and emotional experience.

40 Growing awareness of pain and painful procedures in livestock has led veterinarians and animal  
41 scientists to address this major welfare concern (Steagall et al., 2021). Research suggests that  
42 causing pain to animals evokes a similar repulsion as causing pain to humans (Rushen et al.,  
43 2008). Despite this, pain management in animals remains suboptimal, often due to challenges in

44 pain recognition and assessment, limited treatment strategies, extra-label drug use issues,  
45 impractical drug delivery methods, or economically prohibitive.

46 Castration and disbudding are common management procedures that cause significant pain in  
47 calves. Currently, no analgesic or anesthetic drugs are specifically labeled for pain relief in cattle  
48 undergoing such procedures in the U.S. As a result, veterinarians must rely on extra-label drug  
49 use (ELDU) of analgesics under the Animal Medicinal Use Clarification Act of 1994  
50 (AMDUCA). Castration guidelines from the American Association of Bovine Practitioners  
51 (AABP, 2024) recommend the use of pain management as a standard procedure during  
52 castration. Additionally, the American Veterinary Medical Association (AVMA, 2024) advises  
53 veterinarians to advocate for procedures and practices that reduce or eliminate the pain and  
54 distress associated with castration. Therefore, researchers at Kansas State University are  
55 dedicated to improving cattle welfare by investigating innovative approaches and technologies  
56 for castration pain management. Recent studies have evaluated three promising pain mitigation  
57 strategies: lidocaine-infused bands, Maternal Bovine Appeasing Substance (MBAS), and  
58 castration clips.

### 59 **Lidocaine-Loaded Band**

60 The Lidocaine-loaded band (Lidoband™, Solvet, Calgary, AB) is a latex rubber band infused  
61 with 80 mg of lidocaine, providing local anesthesia starting two hours post-application and  
62 lasting for 42 days (Saville et al., 2020). Our research evaluated this band for castration of 2-  
63 week-old beef-on-dairy calves, comparing it to calves castrated with a control rubber band  
64 without lidocaine over a six-week period. To assess welfare, we measured health, functioning,  
65 behavior, and performance in the calves. The band began cutting through the skin around 21

66 days post-castration, with granulating tissue formation observed at the site. Both treatments  
67 showed increasing probabilities of granulating tissue over time. Overall performance measures  
68 (final body weight, average daily gain, and gain-to-feed ratio) were not significantly different  
69 between treatments; however, weekly analysis showed a slight advantage in average daily gain  
70 for the lidocaine-infused band group during the first week post-castration.

71 Behavioral differences were noted between the treatment groups, particularly during periods of  
72 higher granulating tissue probabilities at the banding site. Calves in the control group spent more  
73 time standing within a bout between days 18 and 22 post-castration, a behavior linked to  
74 reluctance in transitioning between standing and lying positions to avoid stretching the castration  
75 site (Meléndez et al., 2017). Calves with the lidocaine-infused band had more frequent lying  
76 bouts from days 36 to 42 post-castration, suggesting increased comfort in performing the stand-  
77 lie movement. No differences were found in plasma cortisol and substance P levels between  
78 treatments, though cortisol peaked immediately after banding. Results from this study are being  
79 prepared for publication. Currently, analgesics or anesthetics are not commonly used for banding  
80 young or older bull calves in the U.S. Lidocaine-infused bands present a potential alternative to  
81 lidocaine injections, which require proficiency and a waiting period of 5-10 minutes for  
82 effectiveness.

### 83 **Maternal Bovine Appeasing Substance (MBAS)**

84 The sebaceous glands of cows' mammary glands secrete maternal bovine appeasing substance  
85 (MBAS), which has a calming effect on nursing calves. FerAppease® (FERA Diagnostics and  
86 Biologicals, College Station, TX) is a synthetic analog of MBAS applied topically to the nuchal  
87 area and above the muzzle (Pickett et al., 2024). The MBAS are likely assimilated by the

88 vomeronasal organ, which could produce central effects that desensitize brain regions associated  
89 with threat perception and stress. Our research assessed if whether adding a single dose of  
90 MBAS alongside a local anesthetic, or in combination with a systemic analgesic, could extend  
91 pain and stress relief in calves after cautery disbudding and surgical castration, monitoring them  
92 for four weeks. We compared Holstein bull calves receiving only local lidocaine, meloxicam and  
93 lidocaine, MBAS and lidocaine, a MBAS plus meloxicam and lidocaine combination (combo),  
94 sham (no procedures and placebo), and controls (no analgesia or anesthesia).

95 No significant differences were observed in overall performance measures among treatment  
96 groups. Differences from baseline plasma cortisol concentrations (-24 hr pre-treatment) were  
97 higher in control calves compared to sham and MBAS groups, but no significant differences  
98 were found among calves treated with lidocaine, lidocaine and meloxicam, or the combo. Gait  
99 differences were noted in front and hind stance time, with control calves having longer stance  
100 times compared to the lidocaine, MBAS, and combo groups at eight hours post-castration. No  
101 other significant pain-related behavioral differences were found between treatments. Caution is  
102 advised in interpreting these results due to the small sample size and the potential impact of  
103 increased human-animal interaction on normal behavior display. The findings from this study are  
104 currently being prepared for publication.

### 105 **Castration Clip**

106 The ClipFitter (Eadie Bros. & CO. LTD) is a plastic clip applied with a special fitter to scrotal  
107 neck. Its design functions as a hybrid between a Burdizzo and rubber ring, constricting blood  
108 flow to the testis and crushing nerves and the spermatic cord upon application. The clip is  
109 currently used for castration and tail docking in lambs. Our research group evaluated the

110 castration clip in weaned bull beef-on-dairy calves in a one-week pilot study. Calves were  
111 assigned to three groups: castration clip, rubber band castration, and sham. Infrared  
112 thermography of the scrotum at 168 hours post-castration showed lower average temperatures in  
113 calves with the castration clip compared to rubber bands, though no significant differences were  
114 observed between castration clip and castration bands, or between bands and sham calves.  
115 Plasma cortisol and substance P concentrations did not differ between treatments, though cortisol  
116 peaked immediately post-treatment. Automated standing and lying behaviors were assessed for  
117 12 hours daily over seven days. Calves in the castration clip group had shorter average lie bouts  
118 compared to sham calves and longer stand bouts compared to banded calves, though total time  
119 spent lying and standing did not differ significantly between treatments. Further research is  
120 needed to evaluate the long-term effects of this novel castration method, with a focus on pain-  
121 related behaviors over time to account for chronic pain effects.

122 Castration remains a painful management procedure regardless of the technique used. Kansas  
123 State University researchers remain dedicated to improving livestock welfare through new  
124 approaches and technologies that can mitigate castration pain.

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