

Innovative approaches to castration pain management

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Abstract

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

Innovative approaches to castration pain management

Pain is defined by the International Association for the Study of Pain as “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage” (IASP, 1979; Raja et al., 2020). Humans can articulate their pain verbally, specifying its location and intensity, while animals cannot. Thus, Molony and Kent (1997) defined animal pain as “an aversive sensory and emotional experience representing awareness by the animal of damage or threat to the integrity of its tissues; it changes the animal’s physiology and behavior to reduce or avoid the damage, to reduce the likelihood of recurrence, and to promote recovery.” Both definitions emphasize the emotional aspect of pain, which also has incapacitating effects that can compromise survival by impairing the ability to acquire food, water, and shelter. Pain can further affect physical health, causing metabolic changes that interfere with wound healing and lead to immunosuppression, making animals more susceptible to secondary diseases.

Pain and welfare

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

Growing awareness of pain and painful procedures in livestock has led veterinarians and animal scientists to address this major welfare concern (Steagall et al., 2021). Research suggests

that causing pain to animals evokes a similar repulsion as causing pain to humans (Rushen et al., 2008). Despite this, pain management in animals remains suboptimal, often due to challenges in pain recognition and assessment, limited treatment strategies, extra-label drug use issues, impractical drug delivery methods, or economically prohibitive.

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

Lidocaine-loaded band

The lidocaine-loaded band (Lidoband™, Solvet, Calgary, AB) is a latex rubber band infused with 80 mg of lidocaine, providing local anesthesia starting two hours post-application and lasting for 42 days (Saville et al., 2020). Our research evaluated this band for castration of two-week-old beef-on-dairy calves, comparing it to calves castrated with a control rubber band without lidocaine over a six-week period. To assess welfare, we measured health, functioning, behavior, and performance in the calves. The band began cutting through the skin around 21 days post-castration, with granulating tissue formation observed at the site. Both treatments showed increasing probabilities of granulating tissue over time. Overall performance measures (final body weight, average daily gain and gain-to-feed ratio) were not significantly different between treatments; however, weekly analysis showed a slight advantage in average daily gain for the lidocaine-infused band group during the first week post-castration.

Behavioral differences were noted between the treatment groups, particularly during periods of higher granulating tissue probabilities at the banding site. Calves in the control group spent more time standing within a bout between days 18 and 22 post-castration, a behavior linked to reluctance in transitioning between standing and lying positions to avoid stretching the castration site (Meléndez et al., 2017). Calves with the lidocaine-infused band had more frequent lying bouts from days 36 to 42 post-castration, suggesting increased comfort in performing the stand-lie movement. No differences were found in plasma

cortisol and substance P levels between treatments, though cortisol peaked immediately after banding. Results from this study are being prepared for publication. Currently, analgesics or anesthetics are not commonly used for banding young or older bull calves in the U.S. Lidocaine-infused bands present a potential alternative to lidocaine injections, which require proficiency and a waiting period of 5-10 minutes for effectiveness.

Maternal bovine appeasing substance (MBAS)

The sebaceous glands of cows' mammary glands secrete maternal bovine appeasing substance (MBAS), which has a calming effect on nursing calves. FerAppease® (FERA Diagnostics and Biologicals, College Station, TX) is a synthetic analog of MBAS applied topically to the nuchal area and above the muzzle (Pickett et al., 2024). The MBAS are likely assimilated by the vomeronasal organ, which could produce central effects that desensitize brain regions associated with threat perception and stress. Our research assessed if whether adding a single dose of MBAS alongside a local anesthetic, or in combination with a systemic analgesic, could extend pain and stress relief in calves after cauterizing disbudding and surgical castration, monitoring them for four weeks. We compared Holstein bull calves receiving only local lidocaine, meloxicam and lidocaine, MBAS and lidocaine, a MBAS plus meloxicam and lidocaine combination (combo), sham (no procedures and placebo), and controls (no analgesia or anesthesia).

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

Castration clip

The ClipFitter (Eadie Bros. & CO. LTD) is a plastic clip applied with a special fitter to scrotal neck. Its design functions as a hybrid between a Burdizzo and rubber ring, constricting blood flow to the testis and crushing nerves and the spermatic cord upon application. The clip is currently used for castration and tail docking in lambs. Our research group evaluated the castration clip in weaned bull beef-on-dairy calves in a one-week pilot study. Calves were assigned to three groups: castration clip, rubber band castration, and sham. Infrared thermography of the scrotum at 168 hours post-castration showed lower average temperatures in calves with the castration clip compared to rubber bands, though no significant differences were observed between castration clip and castration bands, or between bands and sham calves. Plasma cortisol and substance P concentrations did not differ between treatments, though cortisol peaked immediately post-treatment. Automated standing and lying behaviors were assessed for 12 hours daily over seven days. Calves in the castration clip group had shorter average

lie bouts compared to sham calves and longer stand bouts compared to banded calves, though total time spent lying and standing did not differ significantly between treatments. Further research is needed to evaluate the long-term effects of this novel castration method, with a focus on pain-related behaviors over time to account for chronic pain effects.

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

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