Livestock Science 179 (2015) 22–28

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Hot-iron disbudding: stress responses and behavior of 1- and 4-week-old calves receiving anti-inflammatory analgesia without or with sedation using xylazine

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ARTICLE INFO

Keywords:
Calves
Pain
Disbudding
Sedation
Stress

ABSTRACT

Cattle are often disbudded in a procedure that is painful to them. In an effort to find practical ways to reduce poor welfare due to hot-iron disbudding, we tested a combination of sedation and nonsteroidal anti-inflammatory analgesia (NSAID) that farmers themselves can apply to calves at two different postnatal ages. We compared Prim'Holstein and Charolais calves, male or female, aged 1 or 4 weeks, subjected to hot-iron disbudding without (*vigil calves*), or with sedation (*xylazine calves*, 0.2 mg/kg xylazine 2%), and to sham-disbudded calves without sedation or analgesia (*control calves*). Both groups of disbudded calves received NSAID (3 mg/kg Ketoprofen 10 %®). Calf behavior was observed during disbudding and the following 15 min, and then between 2 h and 7 h post-disbudding. Salivary cortisol and heart rate were measured from 20 min before to 240 min after disbudding. Compared to control and xylazine calves, vigil calves reacted strongly to disbudding by vocalizing (mean vocalizations during the 15 min post-disbudding: vigil calves, 1.95; control calves, 0.2; and xylazine calves, 1.30, a value that was not significantly different from the other two), and higher salivary cortisol concentrations 30 min post-disbudding (vigil calves, 4.08 ng/mL; control calves, 1.59 ng/mL; and xylazine calves, 1.18 ng/mL). An increase in heart rate of 17 bpm above baseline was observed in vigil calves during the 10 min post-disbudding, whereas the heart rate of control calves did not vary and that of xylazine calves decreased by 39 bpm. Significant differences in salivary cortisol concentration and heart rate were observed at 45 min and 30 min post-disbudding, respectively. Vocalizations were observed between 2 and 7 h after disbudding in both vigil and xylazine calves. Responses to disbudding were the same whatever the age, sex, or breed of the calves. The results suggest that sedation with xylazine can reduce the stress calves experience right after disbudding but not after 2 h, and that the pain produced by disbudding is the same at 1 or 4 weeks of age.

1. Introduction

In commercial beef and dairy cattle farms, cattle are often dehorned for a variety of reasons, including safety for animal handling, decreased risk of injury to other cattle, less carcass wastage due to bruising, and less space required at the feeding rack (Mirabito et al., 2009; Stock

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http://dx.doi.org/10.1016/j.livsci.2015.05.013
1871-1413/

et al., 2013). Dehorning raises questions, as it breaches the integrity of animals and can cause stress and pain (Aubry, 2005; Stock et al., 2013). Calves can be dehorned before 2–3 months of age, in which case the procedure is called 'disbudding'. It can be performed by cauterization using a hot iron (hot-iron disbudding), chemical application of a caustic paste on the horn buds (chemical disbudding), or bud amputation using scoop dehorners (surgical disbudding) (Stafford and Mellor, 2005; Algers et al., 2006). Hot-iron and chemical disbudding destroy a ring of skin and under-tissue surrounding the buds that contain specialized cells from which the horns grow (Vickers et al., 2005).

Hot-iron disbudding can be carried out when the buds are 5–10 mm long, i.e. generally up to 8 weeks of age (Stafford and Mellor, 2005). It causes third-degree burns where the hot iron is applied and first and second-degree burns on surrounding tissues (Taschke and Folsch, 1997). The initial cautery damage and the subsequent release of intracellular components from inflammatory cells, activate nociceptors (Anderson and Muir, 2005; Stafford and Mellor, 2005), both of which very probably cause pain (McMeekan et al., 1998; Weary et al., 2006). Following disbudding, calves display behavioral and physiological responses such as ear flicking, head-jerks, head-rubbing, decrease in play behavior, and cortisol release into blood, among others (Stafford and Mellor, 2005; Vickers et al., 2005). In cattle dehorned without analgesia, plasma cortisol concentrations peak in the first 30 min, and then plateaus before returning to baseline at approximately 7–8 h post-disbudding (Stock et al., 2013). A similar pattern of cortisol release, but at lower levels, is apparent following cautery disbudding of calves, where the initial response is likely be due to the pain caused by the cautery itself and the later response to inflammatory-mediated pain (Petrie et al., 1996a; McMeekan et al., 1998).

Behavioral responses such as ear flicking or reduced play behavior can be observed for more than one day post-disbudding (Faulkner and Weary, 2000; Mintline et al., 2013). They may be attributed in part to handling. However, disbudded calves display higher responses than control handled calves and so disbudding per se has an impact (McMeekan et al., 1998; Graf and Senn, 1999; Stafford and Mellor, 2005). Moreover, most behavioral responses are largely reduced when pain relief in the form of local anesthetics or non-steroidal anti-inflammatory drugs (NSAIDs) are administered (Stafford and Mellor, 2005). Therefore, disbudding is likely to induce intense pain in calves.

Administration of local anesthetics around the corneal nerve reduces behavioral and physiological pain responses for about 2 h (lidocaine), 4 h (bupivacaine), or 6 h (lidocaine followed by bupivacaine) (Faulkner and Weary, 2000; Stafford and Mellor, 2005). When the effect of local anesthetics ends, calves display distressful behavior and higher plasma cortisol concentrations suggestive of the inflammatory-mediated pain response (Stafford and Mellor, 2005). Administering analgesics (e.g. the NSAID Ketoprofen) in tandem with lidocaine alleviates pain at least 8 h post-disbudding (Milligan et al., 2005; Stafford and Mellor, 2005; Stock et al., 2013). Finally, sedation (e.g. with xylazine, an α-2 agonist) has been studied alone (Stafford et al., 2003) or in combination with the opioid analgesic butorphanol (GrØndahl-Nielsen et al., 1999) or local anesthetics such as lidocaine (Stafford et al., 2003; Stilwell et al., 2010). The combination lowers the cortisol response and the physical activity of the calves during thermal disbudding, but sedation alone does not eliminate the peak cortisol response and has limited effects on head movements during disbudding (GrØndahl-Nielsen et al., 1999; Stafford et al., 2003; Stafford and Mellor, 2005). Stilwell et al. (2010) suggested that sedation with xylazine without anesthesia might even be stressful to calves. Anesthetics are seldom used in current practice as their unsupervised use by farmers is prohibited or restricted in most countries (Mirabito et al., 2009). In contrast, NSAIDs and sedation can be used if prescribed by a veterinarian, but this is not common practice (Kling-Eveillard et al., 2009). There is a lack of knowledge on NSAID–sedation combination, which, if they proved to be efficacious, could encourage farmers to use them when disbudding calves.

Many countries authorize painful procedures without pain-relief up to a certain postnatal age (e.g. castration of piglets is permitted without anesthesia up to 7 days of age in Europe; Directive 2008/120/CE) on the assumption that younger animals are less sensitive to pain. In cattle, castration seems less painful at 6 days age compared to several weeks or at 1.5 compared to 5.5 months of age (Robertson et al., 1994; Ting et al., 2003). The effect of age on pain response to disbudding is not well documented due to the different methods used at different ages (Morisse et al., 1995).

This study was designed to investigate potential solutions for reducing the impact of hot-iron disbudding on the welfare of calves. Due to the large literature already available on this topic, we focused on few specific

Table 1
Experimental design. Number of male and female calves from the Prim'Holstein or the Charolais breed that were disbudded or sham-disbudded (controls) at 1 or 4 weeks of age. Disbudded calves received Ketoprofen and were sedated or not with xylazine (Xylazine vs. Vigil).

	1 week of age				4 weeks of age			
	Prim'Holstein		Charolais		Prim'Holstein		Charolais	
Treatments	Male	Female	Male	Female	Male	Female	Male	Female
Control	2	3	3	2	2	3	3	2
Xylazine	2	3	3	2	2	3	3	2
Vigil	2	3	3	2	2	3	3	2