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Evaluation of alternatives to cautery disbudding of dairy goat kids using behavioural measures of post-treatment pain

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ABSTRACT

Alternatives to cautery disbudding (caustic paste and cryosurgical disbudding, and clove oil injection) were evaluated using behavioural measures of post-treatment pain in dairy goat kids. Fifty Saanen doe kids were randomly assigned to one of five treatments (n = 10/treatment): (i) cautery (CAUT), (ii) caustic paste (CASP), (iii) cryosurgical (liquid nitrogen; CRYO), (iv) clove oil (CLOV) or (v) sham disbudding (SHAM). Head and body shaking, head scratching, self-grooming and feeding were video-recorded for 24 h pre- and post-treatment. Frequencies of each behaviour were measured over 1 h pre- and post-treatment, as were the durations of head scratching, self-grooming and feeding. Accelerometers measured lying bouts and lying time for 24 h pre- and post-treatment. CASP kids displayed more head shakes (73.7 vs. 38.5 ± 11.06 No./h) and head scratches (35.1 vs. 13.1 ± 6.62 No./h) but less self-grooming (1.3 vs. 10.8 ± 2.00 No./h) and body shakes (1.6 vs. 4.3 ± 0.88 No./h), and shorter feeding durations (1.0 vs. 2.4 ± 0.61 min/h), than CAUT kids ($P \leq 0.05$). CRYO kids performed more head scratches (28.8 vs. 13.1 ± 6.62 No./h) but less body shakes (2.1 vs. 4.3 ± 0.88 No./h), and spent less time lying (15.8 vs. 17.0 ± 0.32 h/24 h) but with more bouts (32.8 vs. 26.3 ± 2.25 No./24 h) than CAUT kids ($P \leq 0.05$). Head shaking, scratching and self-grooming frequencies in CLOV kids (34.0 ± 11.06, 16.7 ± 6.62 and 12.6 ± 2.00 No./h, respectively) were no different to those for CAUT kids ($P > 0.10$). CLOV kids spent less time lying (16.1 vs. 17.0 ± 0.32 h/24 h) (but with more bouts [33.4 vs. 26.3 ± 2.25 No./24 h]) than CAUT kids ($P \leq 0.05$), which suggests less pain, as SHAM kids spent less time lying than CAUT kids (16.2 vs. 17.0 ± 0.32 h/24 h; $P \leq 0.05$). Our results suggest that caustic paste and cryosurgical disbudding were more painful than cautery disbudding and may not be suitable alternatives for goat kids. During the first hour after treatment, clove oil injection appeared to cause less pain than caustic paste or cryosurgical disbudding, but a similar behavioural response as cautery disbudding. Clove oil injection may show promise as an alternative to cautery disbudding. However, future research should first evaluate the efficacy clove oil in preventing horn growth; if effective, further research on the long-term effects of clove oil on goat welfare should be conducted.

1. Introduction

Cautery disbudding is a common husbandry practice performed on calves (Morisse et al., 1995; Graf and Senn, 1999; Grondahl-Nielsen et al., 1999) and goat kids (Alvarez et al., 2009; Ingvast-Larsson et al., 2011) to prevent horn growth, but causes pain and distress. Kids perform higher frequencies of leg shaking during disbudding as well as intense and frequent vocalisations compared with handled controls; these responses appear to be indicative of pain (Alvarez and Gutierrez, 2010; Alvarez et al., 2015; Nfor et al., 2016). Immediately following disbudding, kids also perform frequent head and body shakes, and longer head scratching episodes than handled controls, which may also reflect pain (Greenwood and Shutt, 1990; Hempstead et al., 2017, 2018a). In addition, lying behaviour may be a useful measure of pain for kids; calves disbudded without pain relief spent less time lying than calves disbudded with pain relief (Heinrich et al., 2010). Therefore, behavioural changes, such as head-related and lying behaviours can be used to estimate pain in relation to disbudding.

If cautery irons are used excessively during disbudding, in terms of pressure and timing (associated with poor training), thermal injury to

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the skull and brain may result, which can lead to bacterial infection and consequent meningoencephalitis and mortality in goats (Wright et al., 1983; Sanford, 1989; Thompson et al., 2005). Therefore, it is necessary to investigate potential alternatives to cautery disbudding for goat kids, which cause less post-treatment pain and reduce the risk of injury to the skull and brain. Alternatives to cautery disbudding have been established for calves, but not for goat kids. These methods include caustic paste (Morisse et al., 1995; Vickers et al., 2005; Stilwell et al., 2009; Winder et al., 2017) or cryosurgical disbudding (Bengtsson et al., 1996; Stewart et al., 2014) and clove oil injection (Molaei et al., 2014; Sutherland et al., 2018). Caustic paste has been suggested to be less painful than cautery disbudding in calves based on the evidence of lower rates of head shaking (Vickers et al., 2005). The corrosive action of caustic paste (usually a sodium or calcium hydroxide formulation; Stafford and Mellor, 2011) causes chemical burns and destroys horn bud cells and surrounding tissue (Palao et al., 2010; Papp, 2012). Cryosurgical disbudding, which involves spraying liquid nitrogen (under pressure) onto the horn buds, may also be less painful than cautery disbudding as the skin is not broken and resultant wounds are less severe (Bengtsson et al., 1996; Stewart et al., 2014). Clove oil injection into the horn bud is a novel disbudding technique, which was reported to prevent horn growth in calves (Molaei et al., 2014) and kids (Molaei et al., 2015); Molaei et al. (2015) suggested that the technique was less stressful than cautery disbudding, although no specific measures of pain were presented. Moreover, Sutherland et al. (2018) suggested that clove oil injected under the horn bud of calves was initially less painful and did not cause any more pain than cautery disbudding 48 h post-treatment. Clove oil has been used in dentistry as a mild anaesthetic (Markowitz et al., 1992) and is a well-established fish anaesthetic (Soto and Burhanuddin, 1995; Munday and Wilson, 1997; Sladky et al., 2001). The anaesthetic, anti-inflammatory and cytotoxic properties of clove oil, which contains eugenol as its major component (Markowitz et al., 1992; Prashar et al., 2006), may have application for disbudding.

The objective of this study was to evaluate alternatives to cautery disbudding (caustic paste and cryosurgical disbudding, and clove oil injection) for goat kids using behavioural measures of post-treatment pain. We hypothesised that the application of caustic paste would cause the greatest amount of post-treatment pain due to the extended time course of a caustic burn compared with the other methods (Hettiaratchy and Dziewulski, 2004). We also expected cryosurgical disbudding and clove oil injection to result in less pain than cautery disbudding due to a reduction in tissue damage caused by liquid nitrogen compared with the cautery iron, and the anaesthetic properties of clove oil (Markowitz et al., 1992).

2. Materials and methods

This study was part of a larger study that also evaluated the physiological responses (e.g., plasma cortisol and haptoglobin concentrations, skin surface temperature, and weight gain) to the four disbudding methods considered here (Hempstead et al., 2018b). The same animals were used for both studies.

2.1. Animals and housing

This study used 50 female Saanen or Saanen cross dairy goat kids (mean ± SD, 5.2 ± 0.66 kg) aged 10.6 ± 0.91 d old (mean ± SD) at treatment, and was conducted at the Ruakura Research Farm, Waikato (latitude 37°47'S, longitude 175°19'E), New Zealand during July and August, 2016. The Ruakura Animal Ethics Committee approved the use of animals prior to the commencement of the study (Protocol No. 13899). Goat colostrum was fed to all kids at birth; they were separated from their dam after 24 h. Kids were collected from a commercial farm at approximately 2 d of age and transported to the Ruakura Research Farm. Upon arrival, kids were weighed and given an identification collar, which corresponded with the treatment they received (described below). The kids were vaccinated s.c. (Covexin, Schering-Plough Animal Health Ltd., Wellington, New Zealand) and, as part of routine farm practice, were administered a prophylactic antibiotic s.c. (Norocillin, 30% w/v, Norbrook Laboratories Ltd., Northamptonshire, England). The kids were marked with paint to identify individuals in video-recordings (i.e. a line across the shoulders, or along the spine, a double line across the rump, a cross on the rump or left unmarked).

Kids were housed in groups of five in pre-treatment pens (2.4 x 1.6 m) with concrete floors covered with a 10 cm deep layer of clean, dry bedding (wood shavings, PGG Wrightson, Hamilton, New Zealand). Kids were kept with the same pen-mates for the duration of the trial. Each kid had access to at least 600 mL/d of milk replacer, which was increased gradually to 1 L/d (Anlamb, Fonterra Ltd., Auckland, New Zealand) via a 10-space kid feeder (Milk Bar, Waipu, New Zealand). Milk replacer was provided at approximately 07:00 and 16:00 h with ad libitum access within this period of time. Following the afternoon feeding time, feeders were removed to reduce gut fill impacting body weight measurements the following morning (for the physiological study; Hempstead et al., 2018b). The feeders were then replaced in time for morning feeding. Water was provided in a bucket attached to the pen wall. The daily temperature and relative humidity inside the facility ranged between 6.0 and 24.5 °C (mean ± SEM: 12.9 ± 0.03 °C) and 37 and 93% (69.5 ± 0.18%), respectively.

2.2. Experimental design

Our experiment used a randomised complete block design, blocked by treatment day and pen within treatment day. The kids were randomly allocated to one of five treatments balanced for age (n = 10/treatment). Treatment order was randomly generated by the project manager using Genstat software (Version 17, VSN International Ltd., Hemel Hempstead, UK). Only one kid per treatment was represented per pen and all kids from the same pen were treated on the same day. Treatments were conducted over four treatment days within a 2 wk period. Kids were fed approximately an hour before treatment, and then collected from their pre-treatment pens and restrained in a device described by Hempstead et al. (2018a). For all treatments, hair was removed with an electric clipper (Laube, 505 cordless kit, Shoof International Ltd., Cambridge, New Zealand) prior to treatment to clearly identify the horn buds.

Treatments were carried out in the same room containing the pre- and post-treatment pens by the same veterinarian between 09:00 and 10:30 h each day. Treatments were the same as those described in Hempstead et al. (2018b):

(i) SHAM: Kids were sham-handled and a finger was used to massage each horn bud in a circular motion for 10 s.
(ii) CAUT: Kids were cautery disbudded using an iron ("Quality" electric debudder, 18 mm tip, 230 V, 190 W; Lister GmbH, Lüdenscheid, Germany), which was heated (to approximately 600 °C) for 20 min prior to being held to each horn bud for 5–7 s using methodology described by Hempstead et al. (2017).
(iii) CASP: Kids were caustic paste disbudded using a sodium hydroxide-based paste (Hornex, Shoof International Ltd., Cambridge, New Zealand) that was rubbed onto each horn bud (0.16 mL/bud) using a fingertip (of a gloved hand); a ring of petroleum jelly was spread around each horn bud prior to application to stop the paste from running into the kids' eyes. The caustic paste treatment was based on the protocol described by Vickers et al. (2005) for calves.
(iv) CRYO: Kids were cryosurgically disbudded using a commercial applicator (CryAc® B-700, 500 mL capacity, Brymill Cryogenic Systems, Ellington, CT), which sprayed liquid nitrogen onto each horn bud for 10 s. A device, which consisted of a rubber cone (1 cm diameter touching the head and 2 cm diameter at the other end) connected to a metal handle, was pressed against the head of the