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Evaluation of alternatives to cautery disbudding of dairy goat kids using physiological measures of immediate and longer-term pain

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ABSTRACT

We evaluated alternatives to cautery disbudding of goat kids using physiological measures of immediate and longer-term pain. Fifty Saanen doe kids were randomly assigned to 1 of 5 treatments (n = 10/treatment): (1) cautery disbudding (CAUT), (2) caustic paste disbudding (CASP), (3) liquid nitrogen disbudding (CRYO), (4) clove oil injected into the horn bud (CLOV), or (5) sham disbudding (SHAM). Serum cortisol and haptoglobin concentrations were measured from blood samples collected immediately before treatment (baseline) and at 15, 30, 60, and 120 min and then again at 6 and 24 h post-treatment. An infrared thermography camera was used to take images of the horn buds 24 h pre- and 24, 48, and 72 h post-treatment to measure skin temperature. Body weight was measured daily for 1 wk to assess weight change post-treatment. Images of the horn buds were taken at d 1, 2, and 7 and at 6 wk post-treatment to assess tissue damage and wound healing. Mean cortisol concentrations were elevated in CASP kids 1 h post-treatment relative to CAUT kids. Cortisol concentrations of CRYO kids were higher than those of CAUT kids 30 min post-treatment; concentrations for CLOV kids were similar to CAUT kids post-treatment. Mean haptoglobin concentrations were similar across treatments over time; however, CLOV kids had higher concentrations at 24 h post-treatment than all other treatments. Skin temperatures of CASP and CLOV kids were elevated relative to CAUT kids at all time points post-treatment, and all disbudded kids had skin temperatures above those of SHAM kids at 72 h post-treatment. Treatment did not influence weight gain. The CAUT kids had large, open wounds exposing bone; small scabs were still evident 6 wk post-treatment. The CASP kids had red and open, raw wounds that generated large eschars, apparent for up to 6 wk. The CRYO kids had closed, dry wounds initially, but over time lesions appeared that caused open wounds; small scabs were present 6 wk post-treatment. The CLOV kids had closed, dry wounds with blackened skin; healed skin and minimal scabs were present 6 wk post-treatment. Caustic paste and cryosurgical disbudding appeared to cause more pain compared with cautery disbudding; thus, these methods may not provide good alternatives to cautery disbudding. Clove oil appeared to cause a similar pain response as cautery disbudding and smaller wounds with earlier tissue repair; this method shows promise as an alternative to cautery disbudding.
Key words: caustic paste, liquid nitrogen, clove oil, cortisol

INTRODUCTION

Disbudding of goat kids and calves is performed to prevent horn growth, as horns can cause injuries to other farmed animals and human handlers. Cautery disbudding of kids is a common practice but is painful and can cause health issues (Thompson et al., 2005; Alvarez et al., 2009; Hempstead et al., 2017). Pain in disbudded kids can be assessed using behavioral and physiological responses such as frequent intense vocalizations (Alvarez and Gutierrez, 2010), increased frequencies of head and body shaking, longer bouts of head scratching (Greenwood and Shutt, 1990; Hempstead et al., 2017, 2018), and elevated plasma β-endorphin (Greenwood and Shutt, 1990) and cortisol concentrations (Alvarez et al., 2009, 2015; Hempstead et al., 2018). Calves show defensive behavior during disbudding, such as rearing or dropping to the ground, and responses post-procedure, such as head shaking and ear flicking (Graf and Senn, 1999; Grondahl-Nielsen et al., 1999; Heinrich et al., 2010). Moreover, disbudded calves display elevated cortisol concentrations and heart and respiratory rates (Grondahl-Nielsen et al., 1999; Heinrich et al., 2009), a more variable heart rate, a rapid decrease in eye temperature (Stewart et al., 2008), reduced weight gain when pain relief is unavailable (Bates et al., 2016), and

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heightened sensitivity to pressure applied to the disbudding wounds (Heinrich et al., 2010).

Haptoglobin is an acute phase protein that is produced in response to inflammation and has previously been measured in disbudded calves provided nonsteroidal anti-inflammatory drugs (**NSAID**; Allen et al., 2013). Infrared thermography has also been used in cattle to measure inflammation; higher skin temperatures in tissues of either hot-iron or freeze-branded cattle were found relative to unbranded controls measured at the same position (Schwartzkopf-Genswein and Stookey, 1997). Currently, research assessing inflammatory responses to disbudding in kids is limited. Hence, there is a need to evaluate pain mitigation strategies and alternative methods to cautery disbudding that can cause less pain and less tissue damage and improve wound healing.

Alternative methods to cautery disbudding have been evaluated in calves but have not been assessed in kids. Methods include the application of caustic paste (Morisse et al., 1995; Vickers et al., 2005; Stilwell et al., 2009), liquid nitrogen (i.e., cryosurgical disbudding; Bengtsson et al., 1996; Stewart et al., 2014), and clove oil (Molaei et al., 2014) to horn buds. Caustic paste techniques involve the application of a sodium, calcium, or potassium hydroxide paste that chemically burns the horn bud area; application of these pastes has been reported to be less painful than cautery disbudding in calves based on lower frequencies of head shakes (Vickers et al., 2005). Furthermore, the frequencies of pain-related behaviors (e.g., head rubs, head shakes, tail flicks) were much lower in calves disbudded with caustic paste and a local anesthetic cornual block than in calves treated with caustic paste alone (Winder et al., 2017). Cryosurgical disbudding involves spraying liquid nitrogen on the horn buds to destroy cells and may be less painful than cautery disbudding as it causes a reduced inflammatory response (Bengtsson et al., 1996; Stewart et al., 2014). Clove oil has traditionally been used in dentistry as a mild topical anesthetic (Markowitz et al., 1992) and has antibacterial and anticarcinogenic properties (Chaieb et al., 2007). Furthermore, clove oil is a well-established fish anesthetic (Sladky et al., 2001). Recent studies on calves (Molaei et al., 2014) and goat kids (Molaei et al., 2015) have used clove oil as a novel method of disbudding and have shown arrested growth in horn buds injected with clove oil compared with saline injection. Clove oil, which contains eugenol, has properties (e.g., cytotoxic, necrotizing agent, anesthetic; Markowitz et al., 1992; Prashar et al., 2006) that may have application for disbudding. These methods have the potential to improve goat kid welfare compared with cautery disbudding.

We evaluated alternatives to cautery disbudding (i.e., the application of caustic paste, liquid nitrogen, and clove oil) for goat kids using physiological measures of immediate and longer-term pain. We predicted that the application of caustic paste would cause the greatest pain response and that cryosurgical disbudding and clove oil injection would have the lowest pain response relative to cautery disbudding. We also expected caustic paste to cause the greatest tissue damage and that kids injected with clove oil would benefit from the anesthetic properties of eugenol, a main component of clove oil (Markowitz et al., 1992).

MATERIALS AND METHODS

Animals and Housing

Our study was conducted on 50 female Saanen and Saanen cross dairy goat kids (mean ± SD = 5.2 ± 0.66 kg) aged 9 to 14 d (mean ± SD = 10.6 ± 0.91 d) at the Ruakura Research Farm, Waikato region (37°47′S, 175°19′E), New Zealand, during July and August 2016. The study was approved by the Ruakura Animal Ethics Committee (protocol no. 13899). All kids received goat colostrum at birth and were separated from their dam after 24 h. Kids were transported to the research farm when approximately 2 d old. Once kids arrived, they were weighed and given an identification collar. Kids were also vaccinated subcutaneously (Covexin, Schering-Plough Animal Health Ltd., Wellington, New Zealand) per routine farm practice and prophylactically administered an antibiotic subcutaneously (Norocillin, 30% wt/vol, Norbrook Laboratories Ltd., Northamptonshire, UK).

The animals were housed in groups of 5 in pre-treatment pens (2.4 × 1.6 m). The pen floors were covered with clean, dry bedding (wood shavings, PGG Wrightsons, Hamilton, New Zealand) 10 cm deep. The kids remained with the same pen-mates for the entire trial. Kids were habituated to the pens for 1 d before baseline (pre-treatment) data collection. Kids had access to at least 600 mL of milk replacer/d per kid, which was increased over the study period to 1 L/d per kid (Anlamb, Fonterra Ltd., Auckland, New Zealand), via a feeder. Fresh water was supplied in a bucket attached to the pen wall. Overnight, feeders were removed to reduce gut fill affecting BW measurements the following morning. The feeders were then replaced at approximately 0700 h. Once the BW measurements concluded at 2 wk post-treatment, feeders were left in the pens overnight. Daily temperature and relative humidity within the goat barn ranged between 6.0 and 24.5°C (12.9 ± 0.03°C) and 93 and 37% (69.5 ± 0.18%), respectively.

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