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Original Article

Pain sensitivity and injury associated with three methods of disbudding goat kids: Cautery, cryosurgical and caustic paste

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ABSTRACT

Pain sensitivity and skull/brain injury associated with cautery, cryosurgical and caustic paste disbudding were evaluated in goat kids. Kids (reared for meat; $n = 280$) were randomly assigned to one of four treatments ($n = 70$ per treatment): (1) sham-handling (SHAM) or (2) cautery (CAUT), (3) cryosurgical (CRYO) or (4) caustic paste (CASP) disbudding. A pain sensitivity test was carried out 15 min pre-treatment and 1 h post-treatment. Skull/brain injury was assessed at post-mortem examination. Kids with evidence of injury to the skull/brain, as well as a random sample of kids ($n = 15$ per treatment) without evidence of skull/brain injury, were selected for histological examination of brain tissue. Average daily gains (ADG) were calculated from body weight measurements taken 10 min pre-treatment and then at 2, 7 and 14 days post-treatment as a measure of the potential effects of pain or injury on growth. CASP and CRYO kids displayed higher pain sensitivity post-treatment than CAUT or SHAM kids, suggesting that they experienced more acute pain 1 h post-treatment. One of 70 CAUT kids had a perforated skull, but there was no histological evidence of brain injury in this animal; a further nine CAUT kids exhibited hyperaemia of the skull. The other treatments did not result in injury to the skull/brain. There was no evidence of a difference in ADG across treatments. Caustic paste and cryosurgical disbudding resulted in greater acute pain sensitivity than cautery disbudding; however, cautery disbudding has the potential to cause skull injury if performed incorrectly.

Introduction

Disbudding of goat kids is typically carried out within the first week of life with a hot cautery iron to prevent horn growth. Cautery disbudding of goat kids causes physiological and behavioural changes indicative of pain (Alvarez et al., 2009, 2015; Hempstead et al., 2018a, 2018b, 2018c). Pressure algometry has been used to measure pain sensitivity in calves that were cautery disbudded (Heinrich et al., 2010; Allen et al., 2013); disbudded calves had heightened sensitivity of tissues surrounding the procedural sites than sham-handled controls.

Pain can lead to changes in body weight through reduced feeding motivation (Borderas et al. 2009; National Research Council, 2009). Calves that were cautery disbudded without pain relief had lower weight gains for up to 2 weeks than calves disbudded with pain relief (Faulkner and Weary, 2000; Bates et al., 2015). Pain sensitivity and average daily gains (ADG) associated with disbudding have not been evaluated in goat kids.

Cautery disbudding of goats, if performed incorrectly, can cause damage to the skull, along with thermal injury to the brain and consequent necrosis (Wright et al., 1983; Sanford, 1989; Thompson et al., 2005). Bacterial infection of the brain or meninges can result from the weakened or damaged skull, which can lead to meningoencephalitis and mortality (Thompson et al., 2005). Therefore, it is necessary to investigate alternatives to cautery disbudding of goat kids that are less likely to cause injury to the skull and brain.

In calves, alternatives to cautery disbudding, such as caustic paste (Vickers et al., 2005; Stilwell et al., 2009) and cryosurgical disbudding (Bengtsson et al., 1996), may cause less pain and skull or brain injury than cautery disbudding, as suggested by lower rates of head shaking in caustic paste disbudded calves (Vickers

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et al., 2005). However, recent behavioural and physiological assessments of pain suggest that caustic paste disbudding may be associated with long lasting pain in goat kids (Hempstead et al., 2018b, 2018c). Effective disbudding methods should reduce pain sensitivity, have no adverse effect on ADG and generate no skull or brain injury. The aim of our study was to evaluate pain sensitivity, ADG and skull and/or brain injury associated with cautery, cryosurgical and caustic paste disbudding. We predicted that pain sensitivity would be greatest for caustic paste disbudded kids, and that they would also display the lowest ADG 24 h post-treatment. Furthermore, because the cautery iron makes direct contact with the skull, we predicted that skull and/or brain injuries would be most likely in cautery disbudded kids.

Materials and methods

Animals and housing

This study was conducted on a dairy goat farm in the Waikato region, New Zealand. The study was approved by the Ruakura Animal Ethics Committee (protocol number 13907; date of approval 30 June 2016). The study included a total of 280 Saanen goat kids (58 does and 222 bucks), with a mean ± standard deviation (SD) age of 4 ± 1 days and a mean ± SD body weight of 4.6 ± 0.9 kg. The kids were reared for meat and slaughtered after 19.0 ± 5.4 days, once they reached an average weight of 7.1 ± 0.8 kg. Kids were housed in pens (9.2 m × 3.0 m), which contained approximately 50 kids each. Kids were selected for inclusion if they were 2–7 days of age and had horn buds (i.e. they were not polled). Clinical examinations were only performed by a veterinary surgeon if an animal showed clinical signs of illness.

The kids were reared as per routine farm practice. The ground within the pens was covered with pine shavings (approximately 15 cm deep). The kids had ad libitum access to goat milk colostrum for at least 1 week and were then provided with Sprayfo milk powder (AgriVantage) mixed according to package instructions. Each pen was provided with approximately 100 L of milk in a plastic drum feeder with six teats per drum. Fresh water was always available in a trough.

Experimental design and treatments

A randomised unbalanced incomplete block design was used, with treatment day as the blocking variable. Kids were randomly assigned to one of four treatments (n = 70 per treatment), which were balanced for sex and age. On each treatment day, treatment order was generated randomly. The mean ± standard error of the mean number of kids disbudded per treatment per day was 35 ± 5. To determine sample size, a power analysis with 5% significance level and 80% power was carried out. The primary outcome was disbudding-related deaths (15%) from a study by our group (unpublished data), with data assumed to be binomially distributed.

On treatment days, kids (mean ± SD: 6.0 ± 2.2 days old) were moved one at a time from the home pen to the treatment area and placed in a restraint device (Hempstead et al., 2018a). For all treatments, hair was removed using clippers (Laube, 505 Cordless Kit, Shoof International) to clearly locate the horn buds. All treatments were performed between 10:00 and 14:00 h by the same operator (trained by a veterinary surgeon), with the exception of cautery disbudding, which was performed by a professional contractor.

Treatments included: (1) sham-handling (SHAM): kids were sham-handled and a finger was used to massage each horn bud in a circular motion for 10 s; (2) cautery (CAUT): kids were cautery disbudded using a liquefied petroleum gas powered iron (Heavy Duty, 18 mm tip; Shoof International); the iron (~600 °C) was applied for ~6 s, then the horn bud and surrounding tissue were removed forcibly by using downwards pressure and circular motions; iodine spray (Vetadine PVP, Bomac Laboratories) was then applied to the wounds; (3) cryosurgery (CRYO): kids were cryosurgically disbudded using a commercial applicator (Cry-Ac B-700, Bry-Mill Cryogenic Systems) that sprayed liquid nitrogen onto each horn bud for 10 s; to localise the contact area and protect the kids' eyes, a device consisting of a rubber cone (1 cm diameter touching the head and 2 cm diameter at the Cry-Ac end) connected to a metal handle, was pressed against the head; (4) caustic paste (CASP): kids were caustic paste disbudded using a sodium hydroxide-based paste (Hornex, Shoof International) that was rubbed into each horn bud (~0.16 mL/bud) for approximately 30 s using the fingertip of a gloved hand; prior to the application of the paste, petroleum jelly (Vaseline, Unilever) was spread as a ring around each horn bud to prevent the caustic paste from running into the kids' eyes.

Following treatment, the kids were placed into a small holding pen (2.5 m × 1.5 m) within their home pen until measurements were taken. CASP kids were housed within the same pen as the other kids; any transference of paste between kids was quickly removed. The kids were monitored for up to 2 h immediately after treatment and regularly (every 3 days) for up to 14 days post-treatment to ensure there were no negative effects (e.g., infection) of the disbudding treatments.

Pain sensitivity

Pain sensitivity was measured using a digital pressure algometer (Force one FDIX 50, Wagner Instruments) equipped with a l cm diameter rubber tip, which was applied to four locations around each horn bud (Fig. 1) 15 min pre-treatment (baseline) and 1 h post-treatment as described by Heinrich et al. (2010). The horn bud (left or right) tested first was determined randomly, but the locations around each horn bud were measured in order from one to four for each horn bud (Fig. 1). The amount of pressure a kid tolerated before it withdrew its head was measured in kilograms of force (kgf) and was referred to as the mechanical nociceptive threshold (MNT). Downwards pressure was applied at a steady rate of approximately 1 kgf/s. The algometer automatically read the highest level of pressure applied, and then was manually reset before the next measurement was taken. To maintain consistency, one trained operator performed all of the algometry measurements.

Skull and brain assessment

Prior to slaughter at the abattoir, kids were ear tagged (sheep tags, Allflex) so that the head of each kid could be identified and linked with its treatment. Gross and histological examinations were performed by a veterinary pathologist. The horn bud sites were grossly examined to assess exterior tissue damage to the skin and skull (e.g., ulceration, necrosis and haemorrhage); the heads were then cut transversely, immediately caudal to the horn buds, using a commercial meat band saw. The brain was removed from the front of the skull and the inner surface of the frontal bone was examined for evidence of injury (e.g., discolouration, indentation) or inflammation beneath the horn bud sites. The dorsal surfaces of the cerebral hemispheres beneath these sites were examined for ulcerations or discolouration.

Fifteen heads were randomly selected for histological examination from the SHAM, CASP and CRYO treatments. In the CAUT group, 10 heads that exhibited evidence of skull and brain injury were selected, together with five heads selected randomly. The anterior part of the brain was collected and fixed in 10% neutral buffered formalin. Sections of both the right and left dorsal cerebral hemispheres from beneath the horn bud sites were embedded in paraffin wax for histological examination. Histological sections were cut at 5 μm, stained with haematoxylin and eosin, and examined for histopathological changes by light microscopy.

Body weight measurements

Kids were weighed using a hanging digital scale (Kamer, Shoof International) attached to a weigh cradle immediately pre-treatment (baseline) and then at 2, 7 and 14 days post-treatment. Body weights for each kid were converted to ADG (g).

Statistical analysis

Data were analysed using Genstat version 17 (VSN International). No transformations of the data were required. Change in MNT from baseline was analysed using a mixed model fitted by restricted maximum likelihood (REML). The model included fixed effects for treatment, location and their interaction, and random effects for kid, sex, treatment day, horn bud (left or right) within kid, horn bud order (first or second) and location within kid.

Body weights were excluded from analysis for 89 kids that either died, were missed at the time of measurement or sent to the abattoir before 2 weeks of age. Average daily gains were analysed using a repeated measures model fitted by REML. The model included the fixed effects for treatment, time and their interaction, and random effects for sex, treatment day and kid within time. The correlation in measurements taken on the same kid over time was modelled with a power model of order 1.

Fig. 1. Locations around the goat kid horn buds where the pressure algometer was applied. The horn bud (left or right) tested first was randomly determined, but the order of locations tested remained the same (1 to 4).