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BRIEF COMMUNICATION: A physiological evaluation of the efficacy of pain-mitigation strategies for cautery-disbudded goat kids

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Introduction

Cautery disbudding is a painful procedure commonly performed on-farm to destroy the horn bud cells of goat kids to prevent horn growth. Disbudding is performed because horns can injure pen mates and stock people. Globally, standard practice of disbudding typically excludes the use of pain-mitigation and there are few studies investigating kid responses to disbudding and different pain-mitigation strategies. To date, pain-mitigation strategies used when disbudding kids include administration of non-steroidal anti-inflammatory drugs (NSAIDs), local anaesthesia (LA) and general anaesthesia (GA). Meloxicam (NSAID) reduced pain-related responses in cautery-disbudded kids (Ingvast-Larsson et al. 2011). Local anaesthetics (e.g., lignocaine), however, have not shown to be affective at reducing the pain response following disbudding (Alvarez et al. 2015). General anaesthesia has been used in kids, but its effect on pain-related responses was not assessed (Ingvast-Larsson et al. 2011). The objective of this study was to evaluate the physiological response to different pain-mitigation strategies for cautery-disbudding in goat kids.

Materials and methods

This study was approved by the Ruakura Animal Ethics Committee and was conducted between July and August, 2015, at the AgResearch Ruakura Research Farm, Hamilton, New Zealand.

Animals and husbandry

Fifty, three-week-old (range: 16-26 days), female Saanen dairy-goat kids were sourced from two commercial farms. Kids were randomly assigned to one of five treatment groups and remained with the same pen mates for the entire trial.

Experimental design

This experiment consisted of four treatment days with at least 10 kids treated daily. Treatment groups were balanced for age and treatment order was randomised. One kid from each treatment group was represented per pen. Kids were allocated to one of five treatment groups (n = 10/treatment): 1) CAUT kids were disbudded with an electric cautery iron ("Quality" electric debudder, 230 V, 190 W; Lister GmbH, Lüdenscheid, Germany) pressed on each horn bud for ≤ 8 s, 2) I-MEL kids received meloxicam (0.5 mg/kg of BW) subcutaneously (SC) and then disbudded

using the same procedure as for CAUT kids, 3) ISO kids were sedated using isoflurane gas administered via a face mask. Kids were then disbudded using the same procedure as for CAUT kids, 4) MI kids were sedated using the same procedure as for ISO kids and received meloxicam SC, followed by the same procedure as for CAUT kids, and 5) SHAM kids were similarly handled to simulate the procedure using a cold disbudding iron applied to the horn buds (i.e., not disbudded).

Cortisol and glucose concentrations

Plasma cortisol and glucose concentrations were measured in blood samples (4 mL each) collected from jugular veins at times 0 (pre-treatment), and 15, 60 and 120 min post-treatment. Blood samples were collected into fluoride oxalate tubes (Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ, USA) and were centrifuged at 3000 rpm for 10 min (approximately 1500 g) at 4°C immediately post-sampling. The plasma was separated and stored at -20°C until analysed.

Body weight

Body weight measurements were taken at 24 h pre- and 24 and 48 h post-treatment using a veterinary platform scale.

Statistical analyses

Plasma concentrations of cortisol and glucose, and body weight change were analysed using Genstat software (Version 16, VSN International). Residual plots for all analyses were assessed to detect departure from the model assumptions of normality and constant variance. Transformations were not required. Mean cortisol and glucose concentrations and weight change were expressed as a difference from baseline pre-treatment values. Cortisol and glucose data were run through separate mixed-model repeated-measures ANOVA and weight-change data were run through a uniform correlation model. The statistical models for cortisol, glucose and weight change included the fixed effect of treatment and time and the random effects of kid, treatment date and pen.

Differences in mean plasma cortisol and glucose concentrations and weight change across treatment group and time were compared by Fishers' least significant differences (LSD) test. Mean values were provided with approximate standard error of the difference. The level of significance was set at $P \leq 0.05$.

Results

Cortisol concentrations varied significantly among treatments over time ($F_{8, 73} = 2.25, P = 0.03$). Cautery-disbudded kids had the highest cortisol concentration 15 min post-treatment compared with SHAM kids, and kids of the ISO and MI groups had lower cortisol concentrations than CAUT kids ($P < 0.05$; Fig. 1).

Plasma glucose concentrations differed across treatments ($F_{4, 46} = 3.38, P = 0.02$). Overall, the change in glucose was higher in SHAM than MI kids. Kids treated with GA and NSAID had a smaller change in glucose than I-MEL and ISO kids (all $P < 0.05$; Fig. 2).

There was a difference among treatments for mean weight gain ($F_{4, 79} = 4.26, P = 0.004$). Kids in the CAUT group gained less weight than SHAM, MI and ISO groups 48 h post-treatment ($P < 0.05$; Fig 3). Furthermore, SHAM kids gained more weight than I-MEL kids ($P < 0.05$; Fig. 3).

Figure 1 Change in plasma cortisol concentrations in kids from baseline at 15 min post-treatment across treatments: CAUT (cautery disbudded only), I-MEL (meloxicam injected SC and cautery disbudded, ISO (provided isoflurane gas and cautery disbudded), MI (provided isoflurane gas, meloxicam injected SC and cautery disbudded) and SHAM (sham handled and not cautery disbudded). Bars not sharing a letter are significantly different at $P < 0.05$.

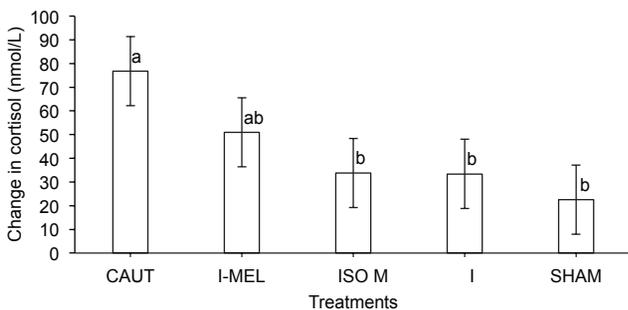


Figure 2 Change in plasma glucose concentrations in kids from baseline across treatments: CAUT (cautery disbudded only), I-MEL (meloxicam injected SC and cautery disbudded, ISO (provided isoflurane gas and cautery disbudded), MI (provided isoflurane gas, meloxicam injected SC and cautery disbudded) and SHAM (sham handled and not cautery disbudded). Bars not sharing a letter are significantly different at $P < 0.05$.

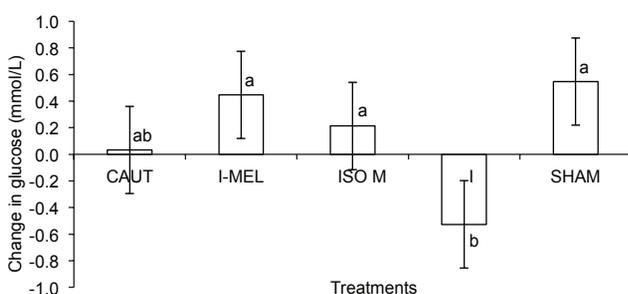


Figure 3 Weight gained from baseline until 48 h post-treatment in kids at across treatments: CAUT (cautery disbudded only), I-MEL (meloxicam injected SC and cautery disbudded), ISO (provided isoflurane gas and cautery disbudded), MI (provided isoflurane gas, meloxicam injected SC and cautery disbudded) and SHAM (sham handled and not cautery disbudded). Bars not sharing a letter are significantly different at $P < 0.05$.

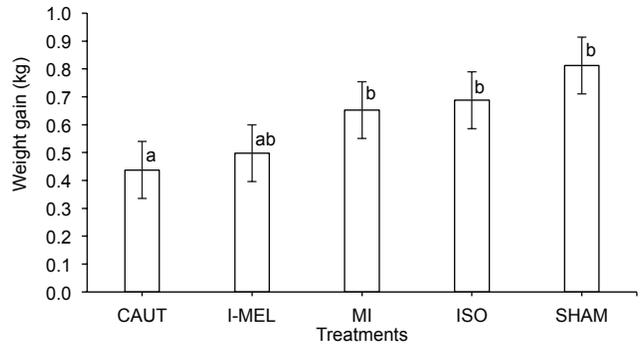


Table 1 Change in plasma lactate concentration (mmol/L) in kids from baseline across treatments over time ($P = 0.6$): CAUT (cautery disbudded only), I-MEL (meloxicam injected SC and cautery disbudded, ISO (provided isoflurane gas and cautery disbudded), MI (provided isoflurane gas, meloxicam injected SC and cautery disbudded) and SHAM (sham handled and not cautery disbudded).

	Time (min)		
	15	60	120
CAUT	0.18 ± 0.36	-0.010 ± 0.36	-0.080 ± 0.36
I-MEL	0.39 ± 0.36	0.070 ± 0.36	0.080 ± 0.36
ISO	-0.36 ± 0.36	-0.10 ± 0.36	-0.40 ± 0.36
MI	-0.48 ± 0.36	-0.38 ± 0.36	-0.35 ± 0.36
SHAM	-0.19 ± 0.36	-0.67 ± 0.36	-0.51 ± 0.36

Discussion

The present study used changes in physiological parameters to evaluate the efficacy of different pain-mitigation strategies for cautery-disbudded dairy-goat kids. Kids disbudded using a cautery iron (without pain relief) had markedly higher cortisol concentrations than SHAM kids suggesting that CAUT kids experienced acute stress or pain associated with horn bud removal. Higher cortisol concentrations have also been reported in disbudded kids (Alvarez et al. 2015) and calves (Sutherland et al. 2002) compared with control animals. Cortisol has commonly been used as an indicator of pain in studies evaluating painful husbandry procedures in several species; however, it is best used in conjunction with other pain indicators as cortisol can change in response to conditions other than pain (Colborn et al. 1991).

At 48 h post-treatment, SHAM kids had higher mean weight gain than CAUT kids suggesting that acute disbudding pain may affect feed intake within this time. Calves disbudded with pain relief had greater weight gain compared with calves disbudded without pain relief (Faulkner & Weary 2000).

Kids that were not disbudded tended to have higher glucose concentrations than CAUT kids. The small difference observed in glucose concentrations in CAUT kids may be due to high baseline values. Ingvast-Larsson et al. (2011) reported no difference in glucose concentrations between disbudded kids and controls.

Kids treated with either isoflurane or isoflurane combined with meloxicam had lower cortisol concentrations, higher weight gain and tended to have lower glucose than CAUT kids. These results suggest that providing isoflurane solely or in combination with meloxicam during disbudding may reduce pain associated with cautery disbudding in kids. As MI and ISO kids were unconscious at the time of disbudding, it is likely that they did not experience the same level of acute pain associated with cautery disbudding as conscious kids.

Meloxicam alone did not appear to reduce the pain caused by disbudding, as cortisol, glucose and weight gain of this group were similar to kids treated with the cautery iron only. In goats, plasma concentrations of meloxicam have been shown to peak at approximately 2-3 h after administration (Ingvast-Larsson et al. 2011; Karademir et al. 2016). In the present study, meloxicam was administered immediately prior to disbudding, therefore meloxicam was unlikely to have taken effect by the time of disbudding.

In conclusion, our results indicate that isoflurane solely or in combination with meloxicam may reduce the pain associated with cautery disbudding in dairy-goat kids and further investigation into the efficacy of NSAIDs to reduce the pain associated with cautery disbudding is warranted.

Acknowledgments

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