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Comparing caustic paste vs caustic stick vs hot-iron+lidocaine disbudding in young dairy calves: behavioral response following disbudding and healing

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Abstract

This study evaluated the behavior of calves following different disbudding methods, and evaluated the scarring between these methods in the weeks that followed. Dairy calves (1 to 15 days of age) were subjected to 1 of 3 methods: caustic paste (CP n = 123), caustic stick (CS n = 123), and hot-iron+lidocaine (HI n = 130). The calf's latency to approach a person was recorded 1 day and 7 days after disbudding. Calves in the caustic paste group were more likely to approach after 1 sec compared to the other methods. Hot-iron+lidocaine disbudding produced smaller scars (0.47 ± 0.26 in (1.2 ± 0.67 cm) mean diameter ± SD vs CS = 1.5 ± 0.47 in (3.8 ± 1.2 cm) and CP = 1.2 ± 0.35 in (3.1 ± 0.90 cm)), but had greater odds of redness (OR = 6.6), purulent discharge (OR = 13.6), and crust (OR = 48.9) 3 weeks after disbudding compared to the caustic methods. Weight gain at 6 weeks was similar between treatment groups. Horn regrowth at 6 weeks and 6 months after disbudding was not different between the methods used, and thus caustic chemicals were as effective as the hot-iron+lidocaine method to disbud dairy calves.

Key words: dehorning, disbudding, fear, behavior, healing

Résumé

L'effet du type d'écornage sur le comportement des veaux et sur la scarification a été étudié dans les semaines suivant la procédure. Des veaux laitiers (1 à 15 jours d'âge) ont été alloués à l'un des trois traitements suivants : pâte caustique (PC, n = 123), applicateur caustique (AC, n = 123), fer chaud et lidocaïne (FL, n = 130). L'intervalle de temps avant l'approche d'une personne a été mesuré aux jours 1 et 7 après l'écornage. Les veaux du groupe PC étaient plus enclins à approcher après 1 s que les veaux des autres groupes. L'écornage dans le groupe FL a produit de plus petites cicatrices (diamètre moyen ± EC : 1.2 ± 0.67 cm vs AC = 3.8 ± 1.2 cm et PC= 3.1 ± 0.90 cm). Toutefois, les chances de rougeur (RC = 6.6), d'écoulement purulent (RC = 13.6) et de formation de croute (RC = 48.9) dans ce groupe étaient plus élevées après l'écornage que dans les deux autres groupes (AC et PC) après 3 semaines. Le gain de poids après 6 semaines n'était pas différent dans les trois groupes. Il n'y avait pas de différence entre les trois groups dans la repousse de la corne suivant l'écornage après 6 semaines et après 6 mois. Par conséquent, les produits chimiques caustiques étaient tout aussi efficaces que la méthode du fer chaud avec lidocaïne pour écorner les veaux laitiers.

Introduction

Disbudding is the removal of horn buds from young calves before they have fused to the skull, after which their removal is referred to as dehorning. The removal of horn buds and horns is a routine husbandry procedure performed on cattle in order to prevent injuries to people working with the cattle, and to other cattle in the herd. Canada's Code of Practice for Dairy Cattle[13] and Beef Cattle[14] and the Canadian Veterinary Medical Association[2] recommend disbudding during the first 3 weeks of life over dehorning.

There are 2 main methods for disbudding currently available: hot-iron and chemical cautery. Hot-iron disbudding involves burning the developing horn tissue with a heated metal probe to destroy the subcutaneous, dermal, and connective tissues to prevent differentiation into horns.[4] Similarly, chemical cautery methods, such as the caustic paste and caustic stick, use strong alkalis to burn the developing horn tissue to prevent horn development. Recent surveys performed in Canada[12,15] and the United States[7] have determined that hot-iron cautery methods are the predominant method utilized by producers (used on 60 to 88% of dairy farms surveyed). Although not as commonly used, some farmers choose caustic chemicals to disbud calves. In a study of 113 US dairies, producers who used caustic paste did so because "it was easy to apply to the very young calf".[7]

Research has shown that the previous experiences of calves can impact their future reactions to stimuli, and an adverse experience can result in a generalized fear of people[3].

An increase in fear of humans by dairy cows is negatively correlated with milk yield, along with fat and protein content[1] and thus, the fear responses generated by disbudding are of interest as they may have an impact on future productivity.[9] Therefore, it may be important to determine if different fear responses result in a decrease in willingness to approach a person from different disbudding methods. Our first hypothesis was that a method that causes more pain will also result in a decrease in willingness to approach shown by an increase in "latency to approach".

The practical efficacy of disbudding methods is determined by whether or not horns develop after treatment. Horn regrowth may require that the animal undergo a dehorning procedure, with associated negative impact on animal welfare, since the animal must again be restrained and subjected to the painful operation. Although disbudding efficacy is of primary and practical importance to producers, this is one of the first studies to compare the effectiveness of different disbudding methods, namely the hot-iron+lidocaine, caustic paste, and caustic stick methods. Our second hypothesis was that there were no differences between the 3 methods.

There were 2 main objectives for this study. The first objective was to measure the fearfulness (latency to approach a person) 24 hours and again 7 days following disbudding, and calf weight gain from arrival at the facility to weaning. The second objective was to compare horn regrowth after the 3 disbudding methods, and to quantify and compare the amount of scarring produced by each method of disbudding.

Materials and Methods

All procedures used in this study were approved by the Animal Care Committee at the University of Guelph, and followed the Canadian Council of Animal Care Guidelines at the time of the study.

Animals, housing and feeding

A total of 376 female Holstein calves ranging from 1 to 15 days of age (mean ± SD = 3.66 ± 2.70 days) were enrolled. In an initial experiment, we were able to capture behavioral data and weight information on 229 calves, while in a second experiment we captured scarring and weight information on 147 calves. All calves were located at a commercial heifer raising facility,[a] where they arrived between 1 and 7 days of age. Calves were housed individually in pens measuring 3.9 x 7.9 ft (1.2 x 2.4 m) with wood shavings for bedding until they were weaned. Calves were fed milk replacer[b] from pails in 2 equal-volume feedings at 0500 h and 1700 h, beginning with a total of 5.3 qt (5 L)/day, and increasing at a constant rate per week to a maximum of 8.5 qt (8 L)/day over 7 days until weaning as per farm protocol for all calves. Calves had access to water *ad libitum* and grain concentrate (22.3% crude protein). Weaning began during week 5: calves were reduced to half their normal volume of milk by continuing the 0500 h feeding of milk replacer and replacing the 1700 h feeding with fresh water; during week 6 they received no milk replacer; and at the start of week 7, they were relocated to indoor pens housing 6 to 8 calves each.

Experimental design and procedures

The study was conducted over a period of 5 weeks from May 30 to June 29, 2005, and consisted of 2 experiments. The first experiment involved a behavioral assessment at time of treatment as well as weight recording at arrival and at weaning. The second experiment involved scoring of the disbudding lesions and weight at arrival and at weaning. Disbudding occurred on 23 different days during the experimental period. Calves were enrolled in the study in groups of 3, matched by age, and randomly assigned to 1 of 3 disbudding treatments: caustic paste, caustic stick, or hot-iron cautery with a lidocaine cornual nerve block. As much as possible, age-matched groups of 3 calves were dehorned in the morning (between 0900h and 1100h) on each day.

In accordance with farm protocol, all calves had the hair around their horn buds clipped upon arrival at the facility. Calves were either disbudded using caustic stick[c] (n = 123), caustic paste[d] (n = 123), or hot-iron[e] (n = 130) + lidocaine[f] nerve block. All calves were manually restrained for disbudding by the same trained farm worker in their home pens. For caustic stick disbudding, 2 drops of water were applied to the horn bud area which was then rubbed vigorously with the caustic stick for approximately 1 min (30 seconds (sec)/horn bud). Caustic paste was applied to a 0.79 in (2 cm) area around the horn bud (estimate of approximately 10 sec/horn bud). Calves that were disbudded using the hot-iron received 5 mL lidocaine injected subcutaneously at the cornual nerve of each horn bud 5 minutes prior to treatment. Subsequently, the hot-iron was heated for a minimum of 10 min (as per label instructions) before being applied to each horn bud (estimate of approximately 22.5 sec/horn bud). No sham disbudding was performed in this experiment.

To determine the effects of different disbudding treatments on calf growth, calf weight was recorded at arrival and at weaning as per farm protocol using a scale.[g] Further, to evaluate the efficacy of the disbudding treatments, horn regrowth was assessed at 6 weeks and 6 months of age for both experiments. Regrowth was scored as 0 (no regrowth of either horn), 1 (regrowth of 1 horn), or 2 (regrowth of both horns). A score of 1 or 2 would require dehorning.

Experiment 1: Behavioral Responses following Disbudding

Calf fearfulness, or willingness to approach, following disbudding was assessed in a subset of calves (n = 170). To gauge calf willingness to approach, the person who performed the procedure stood quietly with gaze averted at the front of the calf's home pen on days 1 and 7 after treatment, and the latency for the calf to approach and make contact with the person's coveralls was scored. The latency test was performed midday to avoid the time when calves were most likely to anticipate being fed, and started when the calf was

standing. Each calf was scored according to whether it made contact with the person immediately, made contact within 120 sec or did not make contact within 120 sec. A maximum latency of 120 sec was set for practical purposes to ensure that the study did not interfere with the daily routine of the facility, and to allow for testing of all calves within a reasonable amount of time. The person moved from the front of 1 calf pen to the next down the row of pens. Calf pens were separated by solid walls so that the calf was unable to see the person until they were at the front of each pen.

Experiment 2: Disbudding Lesion Scoring

At 3 weeks post-treatment, the disbudding scars were assessed by a trained observer. Scar diameter was determined by measuring with a ruler at the largest width on the more severely scarred horn bud (n = 147; caustic paste n = 48; caustic stick n = 48; hot-iron+lidocaine n = 51). This measurement was taken to assess which disbudding method produced the largest area of tissue damage. Additionally, qualitative observations of the disbudding lesions were made by a trained observer, specifically noting any evidence of infection of the lesion (i.e., purulent exudate, presence of a crust, and redness).

Statistical analysis

A priori sampling calculations were based on expected regrowth rate for caustic paste (10%) and portasol dehorner (1%), and 100 calves per treatment group were required to prove statistical significance $P < 0.05$ with a power of 80%. Observational data was entered into Microsoft Excel[h] database and STATA Intercooled 10.1[i] was used for statistical analysis. Linear regression models were used for the weight gain and scar diameter outcomes. All these models had method of disbudding as a variable, and were also tested for source farm as well as arrival weight. Logistic regression models were used to determine the severity of the lesion appearance as well as regrowth of horns, assessed after 6 weeks and 6 months with methods as a variable. Mixed linear regressions models were used to analyze the latency to approach using calves as the random intercept to account for multiple measurements, and with age and method and time as variables. Mixed linear regression was used to identify any continuous trends while controlling for time (1 day and 7 days) and method (caustic paste (CP), caustic stick (CS), and hot-iron+lidocaine (HI)). Linearity of predictors was assessed using a lowess (locally weighted scatterplot smoothing) curve for the continuous independent variables. If the linearity assumption was violated the continuous outcome was either transformed, a quadratic term was included in the model, or the variable was categorized. A 2x3 contingency table with a Fisher-Freeman-Halton probability test extension[10] was used to compare the 3 methods for days 1 and 7 for the following categories: the calf approached in less than 1 sec or not and the calf approached before 120 sec or did not approach during the test.

The animal was considered as the experimental unit. All tests were 2-sided and significance was based on $\alpha \leq 0.05$, and tendency was based on $\alpha \leq 0.1$. Interactions between methods and time in the final model were tested. Standardized residuals were examined to verify model assumptions of normality and homoscedasticity, and to identify outliers at the observation level for both linear and mixed linear regression models, and best linear unbiased predictors (BLUPS) were examined to identify any outliers at the calf level for mixed linear regression models. Normality and homogeneity of variance were assessed for the observation-level standardized residuals, and the BLUPS for the mixed models.

Results

A greater proportion of calves in the CP group approached the person performing the latency test both on days 1 and 7 compared to the CS and HI methods ($P < 0.05$; Table 1). There were no significant differences between any of the disbudding methods in the latency to approach over the 120 sec time allowed for calves to approach ($P = 0.58$; Table 1). Interestingly, as calves got older the latency to approach increased ($\beta = 2.4$ sec; 95% CI = 0.58, 4.2; $P = 0.01$).

In the first experiment of this study, the weight gain (means ± SD) from arrival to weaning (5 weeks after ar-

Table 1. Percent of calves that approached the person performing a latency test on days 1 and 7 by disbudding method (caustic paste, caustic stick, hot-iron+lidocaine) for the calf approached in less than 1 sec or not and the calf approached before 120 sec or did not approach categories.

	Caustic paste (%)	Caustic stick (%)	Hot-iron +lidocaine (%)	Chi-square	*P*-value
No. calves	**54**	**58**	**58**	**–**	**–**
Approached in less than 1 sec on day 1	57.4[a,b]	48.3	39.7	6.31	0.04*
Approached in less than 1 sec on day 7	64.8[a,b]	44.8	48.3	9.15	0.01*
Approached in less than 120 sec on day 1	81.5	79.3	88.0	2.02	0.36
Approached in less than 120 sec on day 7	87.0	82.8	79.3	1.1	0.58

*denotes significant difference ($P < 0.05$) from the Fisher-Freeman-Halton exact probability test

[a]significantly greater than HI ($P < 0.05$); [b]significantly greater than CS ($P < 0.05$), using linear regression

rival) for calves in each method were as follows: CP = 134.2 lb ± 33.7 (61.0 kg ± 15.3), CS = 139.5 lb ± 32.1 (63.4 kg ± 14.6), HI = 134.2 lb ± 29.5 (61.0 kg ± 13.4). There were no significant differences between any of the methods. Calves in experiment 2 of this study had significantly less overall weight gain compared to the calves in experiment 1 (β = -20.9 lb; 95% CI = -30, -11.7) (-9.5 kg; 95% CI= -13.6, -5.3) (P < 0.001). The overall weight gain means (± SD) for the calves from both experiment 1 and experiment 2 in each method were as follows: CP = 111.8 lb ± 51.0 (50.8 kg ± 23.2), CS = 120.1 lb ± 37.84 (54.6 kg ± 17.2), HI = 113.1 lb ± 40.5 (51.4 kg ± 18.4), and again no differences were observed between any of the methods.

The diameter of the scar at 3 weeks post-disbudding was the smallest for the HI method (mean ± SD = 1.2 ± 0.67 cm), and it was significantly smaller than the 2 caustic methods (CP β = 1.8 cm; 95% CI= 1.5, 2.2; P < 0.001; CS β = 2.6 cm; 95% CI= 2.2, 3.0; P < 0.001; Table 2). The CP scar diameter was significantly smaller than the diameter of the scar produced by the CS (CS β = 0.77 cm; 95% CI= 0.38, 1.2; P < 0.001; Table 2). With respect to the severity of the scarring at 3 weeks, calves disbudded using HI disbudding had greater odds of having purulent discharge (OR = 13.6; 95% CI= 3.0, 62.8; P < 0.001), redness (OR = 6.6; 95% CI= 2.7, 15.8; P < 0.001), and a crust (OR = 48.9; 95% CI= 6.3, 381.7; P < 0.001) compared to calves disbudded using CP. Calves disbudded with CP had a greater odds of redness at the site compared to CS calves (OR = 4.4; 95% CI= 1.9, 10.2; P < 0.001). Two calves in the CP group had purulent discharge, and 1 of these also had a crust, while none of the CS calves had purulent discharge or a crust. Only 1 calf in the HI disbudding group had horn regrowth after 6 weeks, and this was the only calf out of 376 animals with horn regrowth after 6 months. Figure 1 shows a typical example of the scar at 6 weeks post-disbudding.

Discussion

Results of the latency to make contact with the person after 1 sec suggest that calves were the most willing to approach after the caustic paste method compared to the caustic stick and the hot-iron+lidocaine methods. Overall, no single disbudding method had a greater impact than the other methods on the latency to approach response of calves recording for 120 sec on days 1 and 7 after treatment. However, the latency test utilized in this experiment was more basic than those used in other studies,[1,8] in that only the amount of time required to approach and make contact with the human were recorded. While this quick and easy latency test allowed for simple data collection at the farm level, it lacked some of the more qualitative components that might provide information on the calf's willingness to approach, and perhaps an insight on its fearfulness. Age of the calf may be another factor that should also be considered for these types of tests, as it seems that as calf-age increased so did the latency to approach. Perhaps another approach could be to investigate the amount of time required to approach at different distances (3.3, 6.6, 9.8, and 13.1 ft; 1, 2, 3, and 4 m) around the motionless human, as well as record the amount of time spent in those areas. The experimental design used in this study did not account for calves that approached the person but failed to make contact. It may have been more beneficial to have the person remain still at the pen gate and measure various distances from the individual that calves may have reached. Furthermore, how quickly they approached the various distances, and how long they remained at those distances would have been potentially useful measurements to compliment the current data. Another approach that may more reliably titrate fear/avoidance response against a known stimulus would be to test willingness to approach at feeding. Given the very strong feeding motivation when calves are meal-fed their milk allotment, an avoidance response would indicate robust avoidance presumably rooted in fear/pain association. Since most calves were willing to approach within 120 sec even in the non-meal period, it would suggest that either the stimulus was not sufficiently aversive to produce a fear/avoidance response, or calves of this age did not make an association between the aversive stimulus and the person that administered it.

Weight gain from arrival to weaning in both groups of calves was not different between any of the disbudding methods (caustic stick, caustic paste, or hot-iron+lidocaine). Insofar as we know, weight gain has not been measured in studies directly comparing various disbudding methods. One study found that calves gained more weight in the 24 hours following hot-iron disbudding when analgesia was provided, compared to those that did not receive analgesia.[6] The amount of calf starter consumed on the day of horn re-

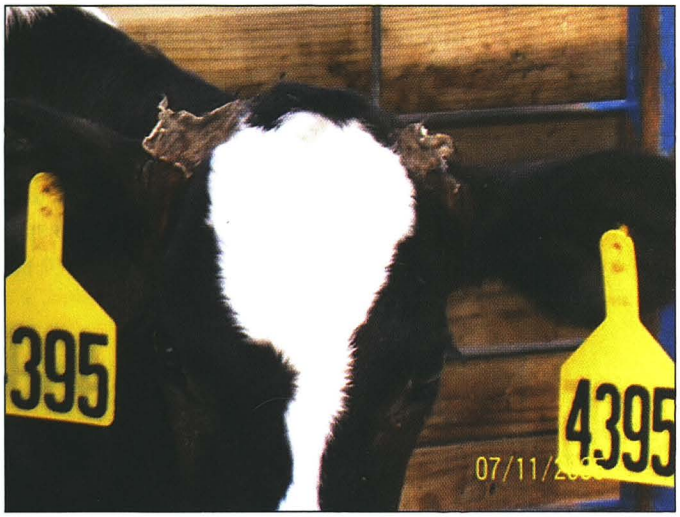
Table 2. Mean (± SD) scar diameter (inches and cm) measured 3 weeks after disbudding in 147 calves for each disbudding method.

Method	No. calves	Mean diameter (cm) ± SD	
		inches	cm
Caustic stick	48	1.5 ± 0.47	3.8 ± 1.20[a,b]
Caustic paste	48	1.2 ± 0.35	3.1 ± 0.90[a]
Hot-iron+lidocaine nerve block	51	0.47 ± 0.26	1.2 ± 0.67

[a]significantly greater than HI (P < 0.05); [b]significantly greater than CP (P < 0.05)

1a. Hot-iron+lidocaine 0.63 in (1.6 cm)

1b. Caustic paste 1.30 in (3.3 cm)



1c. Caustic stick 1.73 in (4.4 cm)

Figure 1a, 1b, 1c. Examples of the scarring at 6 weeks for each of the 3 disbudding methods.

moval has been measured as a method to determine whether analgesia provided an improved recovery from disbudding treatment.[5,11] Results differed in these studies; younger calves (2 to 14 days) did not consume differing amounts of feed, whereas older calves (4 to 6 weeks) did consume differing amounts of feed.[11] Two possibilities arise from these findings: 1) weight is a sensitive marker of stress/pain, and younger calves simply did not benefit from analgesia,[11] or 2) younger calves are less likely to alter feed consumption as a response to stress. Limitations in comparing weight gain results in this study to findings in other studies arise due to the timing of weight gain measurements. Calves in this study were weighed at arrival to the raising facility (≤ 1 week prior to disbudding), and then at weaning (≥ 6 weeks after disbudding), thus minor or acute alterations in feed consumption and associated weight-gain differences may not have been apparent.

At 3 weeks post-treatment, calves disbudded with caustic chemicals had significantly larger areas of scarring compared to hot-iron+lidocaine disbudding, with the caustic stick method producing the largest area of scarring overall. Interestingly, although hot-iron+lidocaine scars were the smallest overall, the severity of tissue damage appeared to be markedly greater in this treatment group as shown by the increased number of events of redness, purulent discharge, and crust. Thus, if the area of scarring caused by caustic chemicals could be minimized, other parameters suggest that wound healing may be better with these disbudding treatments than with the hot iron+lidocaine. Tissue damage from the alkali burns of the caustic stick and paste disbudding methods continues to occur for as long as the caustic chemicals are in contact with the disbudding site.[16] Therefore, the amount of tissue damage may be reduced if the caustic chemicals are either minimized, but still allow for efficacious disbudding, or washed off the area after a certain amount of time following application. Future studies comparing the efficacy, measured via horn regrowth, of caustic chemicals when either minimized or cleared off the skin at different times post-application would be advantageous to refine the standard operating procedure for the chemical disbudding methods. The lack of horn regrowth, except for 1 calf in the hot-iron+lidocaine group, suggests that the 3 disbudding methods are equally effective for preventing horn growth if performed on calves less than 15 days of age (mean of 4 days of age in this study). This finding also supports the potential that caustic procedures in very young calves could likely be refined with less exposure to the caustic agent without sacrificing efficacy or increasing the risk of scours.

Conclusions

Caustic chemical disbudding methods were as effective as the hot-iron+lidocaine disbudding method for preventing future horn growth when used in calves between 1 and 15 days of age. Caustic chemicals produced the largest scars overall, but the severity in scarring differed between the

3 treatments, and scars produced from hot-iron+lidocaine disbudding were more severe in terms of tissue damage. Since the time of this study there have been considerable advancements in protocols and guidelines to manage pain more appropriately following hot-iron disbudding, but research and protocols to manage pain following chemical disbudding are still lacking. Future studies investigating the acute pain to caustic methods vs hot-iron disbudding as well as the longer-term (> 24 hours post-treatment) pain effects associated with wound healing are required to better distinguish the impact of the different methods on calf well-being.

Endnotes

[a]CY Heifer Raising Facility, Elba, NY
[b]Excel Calf Milk Replacer 26/18, Grober Nutrition, New York, NY
[c]HornStick, Albert Kerbl Gmbh, Buchbach, Germany
[d]Dr. Larson's Dehorning Paste, The Doctor Larson Company, Spring Valley, WI
[e]Portasol II, Oglesby & Butler, Carlow, Ireland
[f]2% lidocaine HCL, West Lake, TX
[g]Tru-Test SR 2000, Aukland, New Zealand
[h]Microsoft Corporation, 2010, Redmond, WA
[i]StataCorp, College Station, TX

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