Effects of calf weaning method on calf stress, hormone concentration, growth performance and carcass ultrasound characteristics*

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The study objective was to determine the effects of conventional weaning versus two-step weaning on calf stress, hormone concentration, growth performance and carcass ultrasound characteristics on growing crossbred calves. These results suggest that two-step weaning may alleviate some stress compared with conventional weaning; however, feed efficiency for calves in the traditional weaning treatment was superior to the two-phase treatment.

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Summary

Crossbred steer and heifer calves (n = 71) were stratified by body weight (BW) and allotted randomly to one of two weaning treatments (TRT): conventional weaning (CON) or two-step weaning (2P) in a completely randomized design. Blood samples were collected concurrently with rectal temperature assessment on days -7, -6, -4, 0, 1, 3, 7 and 10 relative to weaning (day 0) for determination of plasma cortisol and haptoglobin concentrations. A subset of calves (n = 12; six calves per TRT) were fitted with human pedometers to measure steps taken before and after weaning.

On day 0, calves were allotted by TRT and sex to one of 12 feedlot pens (six pens per TRT) for a 65-day background period. Calves were fed a growing diet [11.5 percent crude protein (CP), 4.08 Mcals net energy gain (NE_g); dry-matter (DM) basis] for a 2.2-pound average daily gain (ADG). Calf age at weaning and initial BW averaged 160 ± 2 days and 526 ± 8 pounds for both treatments, respectively.

Calf BW and dry-matter intake (DMI) during backgrounding were similar ($P \geq 0.10$) across TRT; however, treatment by sex interactions occurred for ADG and gain-to-feed ratios (G:F; $P = 0.001$ and $P = 0.01$, ADG and G:F, respectively). Furthermore, CON G:F from day 0 to 65 was greater than 2P G:F (0.19 vs. 0.15; $P = 0.05$).

Haptoglobin absorbance was similar ($P \geq 0.10$) for weaning method. Concentrations of cortisol and pedometer steps recorded tended to be effected by a TRT by day interaction ($P < 0.10$). Carcass ultrasound characteristics did not differ ($P \geq 0.15$) for weaning method.

These results suggest that two-step weaning may alleviate some stress compared with conventional weaning; however, feed efficiency for calves in the traditional weaning TRT was superior to the two-phase treatment.

Introduction

Conventional weaning, defined as the sudden removal of a calf from its dam and mother's milk (Haley et. al, 2005), is the traditional weaning method used by most cattle producers. It can be a very stressful experience for young calves because during weaning, calves experience loss of maternal contact, new diets and novel social environments, as well as transportation to new housing facilities (Enriques et al., 2010). Weaning initiates behavioral and physiological responses indicative of distress that are unfavorable to beef production and animal welfare (Lefcourt and Elasser, 1995; Stookey et al., 1997; Krebs et al., 2010), causing morbidity and mortality at feedlot arrival (Loerch and Fluharty, 1999).

Two-step weaning, a weaning alternative using anti-suckling nose tags, has been reported to reduce stress during the weaning process (Carter et al., 2010). The process allows calves to remain with their mothers, adjusting to milk removal prior to physical separation (Loberg et al., 2007). Little research, however, has evaluated how weaning stress influences carcass characteristics during the growing period. We hypothesized that the two-step weaning method would reduce calf stress and improve calf growth and carcass characteristics compared with conventional weaning.

Materials and Methods

All animal care and handling procedures were approved by the North Dakota State University Institutional Animal Care and Use Committee prior to the initiation of this study.

The experiment was conducted at the North Dakota State University Hettinger Research Extension Center's (HREC) Southwest Feeders feedlot and two-319 acre pasture locations. One pasture was 2.5 miles south of Hettinger (Clement) and the other was five miles west of Hettinger (Fitch).

The Clement and Fitch pastures housed 36 and 35 cow-calf pairs, respectively. Seventy-one crossbred steer (n = 36) and heifer (n = 35) calves were used in this study (day -7 to 65). Before weaning, cow-calf pairs grazed the respective pastures containing similar vegetation and portable wind breaks. Two creep feeders, with oat grain as creep feed, were placed on the pastures 65 days before weaning.

All calves were gathered; vaccinated for respiratory, clostridial, *H. Somnus* and Mannheimia diseases; and weighed 33 days before weaning to obtain preweaning calf BW. On day -7, cow-calf pairs were gathered on respective pastures, with calves stratified by preweaning BW and allotted randomly to one of two weaning treatments (TRT): traditional weaning (CON) or two-step weaning (2P).

Anti-suckling nose tags (flexible, one-piece plastic tags; QuietWean nose tags, JDA Livestock Innovations Ltd., Saskatoon, Canada), were placed into the nostrils of the 2P calves. The tags were monitored to ensure retention; any calf that lost its nose tag had another one inserted. The tags remained in the 2P calves' nostrils for seven days, and all calves remained on pasture with their dams until conventional weaning (d 0).

On day 0, cow-calf pairs were gathered on the respective pastures; calves were separated from their dams, loaded into livestock trailers and transported to the feedlot. Calves were weighed and bled, pedometer measures were recorded and ultrasound carcass characteristics were measured. Calves were allotted by TRT and sex to one of 12 feedlot pens (six pens per TRT; five or six calves per pen) for a 65-day background period. Calf age at weaning and initial BW averaged 160 ± 2 days and 526 ± 8 pounds, respectively.

During the first four days in the feedlot, calves had free-choice access to grass hay, plain salt blocks and water in automatic electrically heated fence-line water fountains. On days 2 and 3, oat grain (21.3 pounds per pen; DM basis) was offered. On day 3, calves were fed a growing diet (4.8 pounds per calf; 11.5 percent CP, 4.08 Mcal of NE_g; DM basis) in the form of a totally mixed ration (TMR); the diet consisted of ground mixed hay, corn, barley, oat silage, a custom calf pellet containing Rumensin® (200 milligrams per pound, as fed), deccox® (569 milligrams per pound, as fed) medicated crumbles and calcium carbonate at 53.9, 16.5, 11.5, 9.9, 5.9, 1.7 and 0.6 percent, respectively (DM basis). The TMR was fed once daily (9 a.m.) from days 4 through 65, with adjustments to intake made daily.

Data measures (calf BW, blood samples, rectal temperatures, pedometer and ultrasound measures) were collected before calf feeding on collection days. All calves were bled via the jugular vein relative to weaning (day 0) for plasma cortisol and haptoglobin concentrations.

A subset of calves (n = 12; six calves per TRT) were fitted with human pedometers (GOsmart Tri-Axis pocket pedometer, model HJ-303, Omron Healthcare Inc., Bannockburn, Ill.) on day -7 to measure steps taken before and after weaning. The pedometers were placed in plastic zipper-top bags to protect them from moisture. Bags were fastened securely to the inside of the calf's left rear leg (below the hock and above the fetlock) with veterinary wrap and duct tape, and checked regularly for signs of swelling, discomfort or pain.

On day 10, pedometers were removed from the calves. On day 0 and 65 of the background period, back fat thickness, ribeye area, rump fat thickness and intramuscular fat percentages were measured via real-time ultrasonography, and marbling scores were calculated from intramuscular fat percentages.

Calves were checked daily for signs of illness during the weaning and backgrounding periods. On day 14, all calves were revaccinated for respiratory, clostridial, *H. Somnus* and Mannheimia diseases; dewormed; and implanted with a Ralgro® implant (36 milligrams zeranol). During the background period, diet samples were collected weekly from each pen at feed delivery, composited, dried in a forced-air oven and ground for nutritional analysis by a commercial laboratory (Midwest Laboratories, Omaha, Neb.).

Results and Discussion

Feedlot performance: Calf BW averaged 710 ± 16.7 pounds, with 189 ± 11.2 pounds gained ($P > 0.10$; Table 1) at the end of the 65-day backgrounding period. Average daily gain was similar ($P = 0.10$) across TRT during backgrounding despite CON calves having a numerically higher ADG than 2P calves (3.08 vs. 2.64 pounds per day, CON vs. 2P calves, respectively). Dry-matter intakes averaged 16.2 ± 0.6 pounds per day; however, feed efficiency (gain:feed) was greater ($P = 0.05$) for CON than 2P calves (0.19 vs. 0.15, CON vs. 2P, respectively; Table 1) at the conclusion of the study.

Hormone concentrations and physiological measures: When animals undergo stress, fear, flight, infection, physical trauma and malignancy, these external and internal processes will alter an animal's hormonal balance. Hormones are the chemical messengers to the animal's body tissues and organs; these messengers (hormones) regulate specific metabolic body processes, whereby they either can stimulate or retard (prevent) life activities.

Cortisol, a hormone from the adrenal cortex that causes liver glycogen and blood sugar stores to increase as part of the "flight or fight" response, is the primary biological marker used to measure stress or fear in animals. Another physiological reaction that can result from these internal or external stressors is the acute-phase response. This response stimulates increased production and mobilization of leukocytes (the white blood cells responsible for ingesting infectious microorganisms), and fever, as well as changes in tissue metabolism and circulating levels of acute-phase proteins.

Haptoglobin, one of the acute-phase proteins, is a glycoprotein produced by the liver that binds to freed hemoglobin resulting from infection or tissue injury. The goal of this complex series of reactions is to prevent ongoing tissue damage, isolate and destroy infectious organisms, and activate repair processes necessary to restore the animal's normal body functions (Baumann and Gauldie, 1994).

In our study, we measured cortisol and haptoglobin concentrations as indicators of weaning stress. Haptoglobin absorbance did not show a sex ($P = 0.93$) or TRT-by-sex interaction ($P = 0.81$), but a day effect ($P < 0.002$) was observed (Figure 1).

Both TRT groups had elevated plasma haptoglobin absorbance occurring on day 10.

Although cortisol concentrations were not affected by TRT ($P = 0.13$), we found a tendency ($P = 0.06$) for a treatment-by-day interaction for cortisol (Figure 2). Peak cortisol concentrations for 2P (52.7 nanograms per millilitre, or ng/ml) occurred on day -4, 72 hours post nose tag insertion, while peak cortisol concentrations for CON (43.6 ng/ml) occurred on day -6, 24 hours after the calves first were handled.

Table 1. Effect of weaning method on calf growth performance.

	Treatment[1]			
Item	**CON**	**2P**	**SEM[2]**	***P* – value[3]**
No. head	36	35	–	–
No. pens	6	6	–	–
Initial weight, lbs.	521	530	8.4	0.99
Final weight, lbs.	708	711	16.7	0.99
Weight gained, lbs.	194	183	11.2	0.53
DMI, lbs./day	15.6	16.7	0.6	0.19
ADG, lbs./day	3.08	2.64	0.2	0.10
Gain:feed, lbs./lbs.	0.19	0.15	0.01	0.05

[1]Treatments: CON = conventionally weaned calves; 2P = two-step weaned calves.
[2]Standard error of mean; n = 6.
[3]*P*-values for *F*- test of treatment.

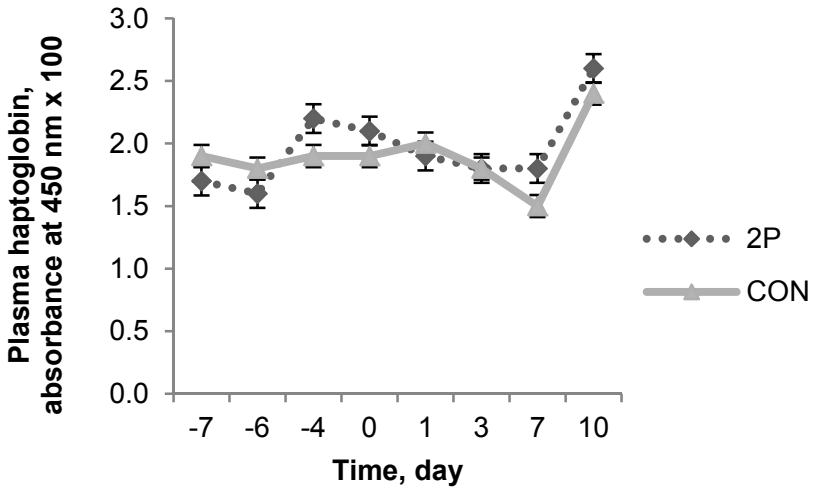

Figure 1. Effect of weaning method on plasma haptoglobin concentration (absorbance at 450 nm x 100; ±SEM). Effects of treatment ($P = 0.69$), day ($P = 0.002$) and treatment x day ($P = 0.43$).

Generally, plasma cortisol concentrations spike immediately following a stress (Lefcourt and Elasser, 1995).

Except for receiving preweaning shots, none of the calves were acclimated to human handling before this study. Grandin (1998) reported that an animal that has not been acclimated to human handling and restraint in a squeeze chute will have more fear stress when it is restrained and handled than one that has been habituated to human contact and trained to handling procedures.

A tendency was noted for a treatment-by-day effect ($P = 0.09$) in the number of pedometer steps recorded (Figure 3). The 2P calves took more steps per day by day -4 (754 vs. 526 steps, 2P vs. CON, respectively) because the 2P calves were unable to suckle, relying on pasture forages and creep feed for their daily nutrition. Conversely, CON calves took more steps per day by day 3 (460 vs. 162 steps, CON vs. 2P, respectively).

Ultrasound measures: Carcass ultrasound characteristics did not differ ($P \geq 0.16$; Table 2) for weaning method. Back fat and rump fat thickness changes were similar ($P \geq 0.94$), averaging 0.025 ± 0.01 inch and 0.02 ± 0.01 inch for CON and 2P calves at the end of backgrounding. Ribeye area, intramuscular fat percentage and marbling scores were not statistically different ($P \geq 0.73$).

Implications

As the cattle industry comes under increased scrutiny from its consumers and outside entities, who demand the industry utilize more animal-friendly production methods, cattle producers must consider less stressful, more humane methods of weaning calves than conventional weaning. These

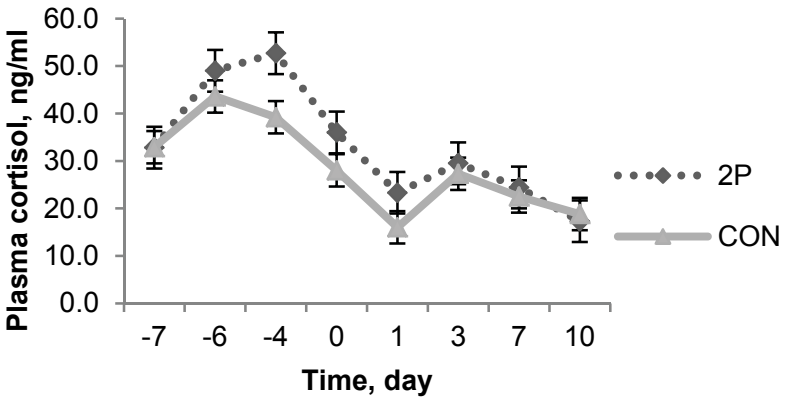

Figure 2. Effect of weaning method on plasma concentration of cortisol (ng/ml; ±SEM). Effects of treatment ($P = 0.13$), day ($P < 0.001$) and treatment x day ($P = 0.06$).

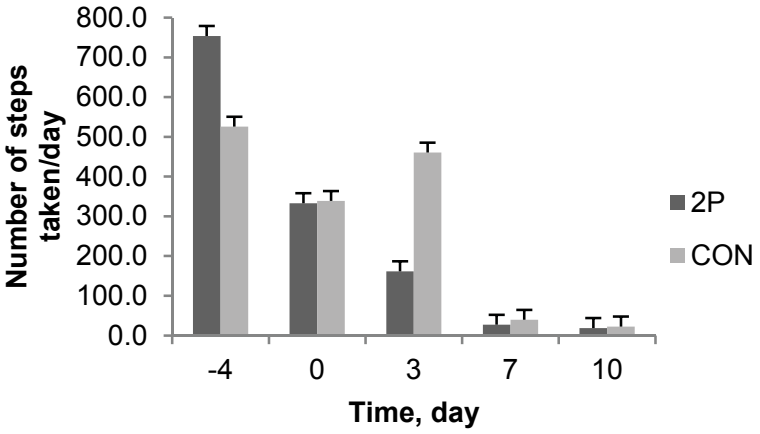

Figure 3. Effect of weaning method on number of steps taken per day (±SEM). Effects of treatment ($P = 0.91$), day ($P = 0.03$) and treatment x day ($P = 0.09$).

Table 2. Change in real-time ultrasound carcass characteristics during the background period.

	Treatment[1]			
Item	CON	2P	SEM[2]	*P* – value[3]
No. head	36	35	-	-
No. pens	6	6	-	-
Ribeye area, in.2	1.83	2.17	0.17	0.16
Back fat thickness, in.	0.03	0.02	0.01	0.94
Rump fat thickness, in.	0.02	0.02	0.01	0.96
Intramuscular fat, %	0.95	0.90	0.11	0.74
Marbling score[4]	0.75	0.71	0.08	0.73

[1]Treatments: CON = conventionally weaned calves; 2P = two step weaned calves.
[2]Standard error of mean; n = 6.
[3]*P*-values for *F*- test of treatment.
[4]Marbling score was calculated from intramuscular fat percentages.

results suggest that two-step weaning may alleviate some stress compared with conventional weaning; however, feed efficiency for calves in the traditionally weaned TRT was superior to the two-phase treatment. Continued evaluation of two-step weaning is necessary.

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