Performance and Health of Weanling Bulls After Butorphanol and Xylazine Administration at Castration

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ABSTRACT: A total of 288 crossbred, 6- to 9-mo-old, bull calves (214 ± 19 kg) were used in two separate 27-d experiments to assess the effects of butorphanol and xylazine administration (BXA) on the subsequent performance and health of beef calves. In each experiment, calves were randomly allotted to four treatment groups: 1) castration with BXA, 2) castration without BXA, 3) no castration with BXA, and 4) no castration without BXA. There were two replicates within each experiment. The intravenous administration of .07 mg/kg of butorphanol and .02 mg/kg of xylazine occurred 90 s before tail hold and castration procedures. Calves were placed in a squeeze chute and manually restrained by tail elevation. In Exp. 2, the cattle also were scored for chute activity (on a 1 to 5 scale with 5 being the most active). Cattle were weighed at the beginning and end of the experiment, feed intake was recorded daily, and cattle were monitored daily for respiratory disease. There were no castration × BXA interactions (P > .51). Castration reduced (P < .01) daily gain and gain/feed and tended (P = .13) to reduce feed intake. The administration of BXA had no effect (P > .05) on gain or gain/feed but did tend (P = .13) to reduce feed intake. No differences (P > .45) were observed in morbidity or mortality due to either BXA or castration. Castration and BXA increased (P < .01) blood cortisol levels on d 3, whereas control animals had reduced cortisol levels. Castration increased (P < .05) haptoglobin levels on d 3, but BXA had no effect (P > .05) on serum haptoglobin concentrations on d 3. Chute activity was reduced (P < .05) by castration and BXA. In this study, animal performance was reduced by castration. The administration of BXA did not alter stress indicators or improve performance of castrated bull calves. Serum haptoglobin may be a more specific indicator of the inflammatory process in cattle, whereas serum cortisol may be an indicator of the whole-body stress response.

Key Words: Castration, Bulls, Analgesics

Introduction

In a review, Seidemen et al. (1982) concluded that, compared with steers, intact male calves grow more rapidly, utilize feed more efficiently, and produce a higher-yielding carcass with less fat and more edible product. However, the disadvantages of raising intact male calves include aggres-

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before castration. However, many calves are not castrated at 2 to 3 mo of age and enter marketing channels intact at weaning (approximately 230 kg). The objectives of this study were to evaluate the effects of the administration of butorphanol and xylazine (BXA; agents known to induce analgesia) and castration on weanling calf performance (i.e., weight gain, feed intake, etc.) and postoperative stress.

Materials and Methods

Two hundred sixty-eight crossbred, 6- to 9-mo-old, bull calves (214 ± 19 kg) were purchased through an order buyer from cattle sales in southern Illinois, southwestern Indiana, western Kentucky, and southeastern Missouri. The bull calves were used in two 27-d experiments to assess four treatments at the time of processing (d 0), either castrating bulls or leaving them intact, with or without BXA, in a 2 × 2 factorial arrangement. The bulls were randomly allotted to four treatments and two replications within each experiment. One experiment was initiated in September, and the second experiment was initiated in November.

Butorphanol (.07 mg/kg; Fort Dodge Laboratories, Fort Dodge, IA) and xylazine (.02 mg/kg; Haver-Lockhart, Shawnee Mission, KS) were administered intravenously 90 s before the tail hold and castration procedures. Calves were placed in a squeeze chute and manually restrained by tail elevation. The scrotum was incised with a Newberry castrator (Haver-Lockhart, Shawnee Mission, KS). Testes were removed manually using a closed technique in which the tunica vaganalis and the major portion of the cremaster muscle was removed along with the testis (Walker and Vaughan, 1980). In Exp. 2, the cattle were scored for chute activity (Tulloh, 1961) after the tail hold procedure.

Cattle were weighed upon arrival for an initial weight and 16 h after removal from feed and water at the end of the experiment. All diets were balanced to meet or exceed NRC (1984) requirements for a daily gain of .4 kg (Table 1). Feed was removed along with the testis (Walker and Vau-

Table 1. Diet composition and mineral supplement composition

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fescue silage</td>
<td>70.6</td>
</tr>
<tr>
<td>Corn</td>
<td>14.7</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>14.7</td>
</tr>
<tr>
<td>Salt</td>
<td>87</td>
</tr>
<tr>
<td>Mn</td>
<td>.22</td>
</tr>
<tr>
<td>Cu</td>
<td>.20</td>
</tr>
<tr>
<td>Fe</td>
<td>2.85</td>
</tr>
<tr>
<td>Zn</td>
<td>2.3</td>
</tr>
<tr>
<td>I</td>
<td>.01</td>
</tr>
<tr>
<td>Se</td>
<td>.0086</td>
</tr>
</tbody>
</table>

*Contained 284,000 IU/kg of vitamin A and 4,400 IU/kg of vitamin E.

diagnosed as having respiratory disease were treated from the onset of clinical signs until 1 d after signs of respiratory disease were not clinically evident.

All calves were tagged, tattooed, bled, vaccinated, and treated for internal and external parasite infection on d 0. This occurred just before the tail hold and castration procedures. Blood was also collected on d 3 and 7 in Exp. 1. All blood was collected in serum separator tubes (Fisher Scientific, Pittsburgh, PA), and serum was removed within 1 h after collection to reduce the risk of hemolysis. All serum samples were stored at −20°C before haptoglobin and cortisol determinations. Serum cortisol and haptoglobin concentration values for d 0 were used as a baseline for each animal; thereafter, the d-3 and -7 samples were compared to d-0 values.

Serum haptoglobin concentrations were determined using a spectrophotometric assay based on cyanmethemoglobin-binding capacity (Elson, 1974; Harvey, 1976). Stock cyanmethemoglobin solutions were prepared using erythrocytes from a single bovine donor. Erythrocytes were washed three times in .9% saline and the packed cells were lysed by addition of freshly prepared Drabkin’s solution (Fisher Scientific). Stromal debris was removed by centrifugation (30,000 × g at room temperature for 15 min) followed by filtration through a .45-μm filter. The cyanmethemoglobin-rich supernate was then diluted to a concentration of 60 mg/dL. Cyanmethemoglobin concentrations were determined spectrophotometrically using a 1/4 mM cyanmethemoglobin extinction coefficient of 11.0 at 540 nm and a molecular weight of 64,458 Da for the hemoglobin tetramer. Haptoglobin values were reported as cyanmethemoglobin-binding capacity per deciliter (CyanBC/dL) and determined using test and blank incubations at 380 and 405 nm. Standardized cyanmethemoglobin solutions were stored in dark glass bottles at 4°C and
ACTH was used to demonstrate parallelism of the assay when comparing human and bovine serum collected from normal bull calves (challenged with butorphanol and xylazine [BXA] administration).

Table 2. Performance, health, and chute activity scores of cattle after castration and/or butorphanol and xylazine (BXA) administration

<table>
<thead>
<tr>
<th>Item</th>
<th>Castration</th>
<th>BXA</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain, kg/d</td>
<td>0.42</td>
<td>0.28</td>
<td>0.38</td>
</tr>
<tr>
<td>Intake, kg/d</td>
<td>3.8</td>
<td>3.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Gain/feed</td>
<td>.07</td>
<td>.09</td>
<td>.09</td>
</tr>
<tr>
<td>Morbidity, %</td>
<td>45</td>
<td>49</td>
<td>48</td>
</tr>
<tr>
<td>Mortality, %</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Chute score</td>
<td>3.0</td>
<td>2.7</td>
<td>3.1</td>
</tr>
</tbody>
</table>

\textsuperscript{a,b}Values in a row within castration or BXA not having a common superscript differ \( P < .01 \).

\textsuperscript{c}Values in a row within castration or BXA not having a common superscript differ \( P < .05 \).

\textsuperscript{d}Secondary morbidity after all animals experienced morbidity.

\textsuperscript{e}On a 1 to 5 scale with 1 being least active.

Serum cortisol concentrations were determined using a commercial RIA kit (Coat-a-count, Diagnostic Products, Los Angeles, CA), which was validated for use with bovine serum. Serum collected from normal bull calves (challenged with ACTH) was used to demonstrate parallelism of the assay when comparing human and bovine serum cortisol concentrations. No modifications were made to the method established by the manufacturer. Twenty-five microliters of serum was pipetted into antibody (anticortisol)-coated tubes and 1.0 mL of \([^{125}I]\) labeled cortisol tracer buffer was added. Each tube was vortexed and incubated for 45 min at 37°C. After incubation the tubes were decanted, washed, and counted for 1 min in a fourwell gamma counter (Model 4-200, ICN Micromedic Systems, Huntsville, AL). Standard curves were constructed using logit (%B/Bo) vs log (cortisol concentrations) regression analysis. The CV within and between assays was < 5%.

Performance data were evaluated using an analysis appropriate for a factorial arrangement of treatments with pen as the experimental unit. Main effects of experiment, replication, castration, and BXA were evaluated using the GLM procedure and least squares means of SAS (1982). The model statement included experiment, replication, castration, BXA, time, and their interactions as the independent variables, with the remainder as the residual error term.

### Results and Discussion

Only main effects are presented because there were no castration \( \times \) BXA interactions \( P > .51 \). Castration reduced \( P < .01 \) daily weight gain and gain/feed and tended \( P = .13 \) to reduce feed intake (Table 2). Worrell et al. (1987) reported that calves castrated at a similar weight (230 kg) gained more slowly and were less efficient than intact males in a 196-d trial. In the present study, BXA had no effect on weight gain or gain/feed but did tend \( P = .13 \) to reduce feed intake. The trends for reduced intake due to castration and BXA were consistent throughout the 27-d experimental period and were most likely not due primarily to differences in intake on d 1. On d 1, castration tended \( P = .12 \) to reduce feed intake (2.55 to 2.01 kg) and BXA tended \( P = .14 \) to reduce feed intake (2.53 to 2.03 kg). No differences \( P > .45 \) were observed in morbidity or mortality due to BXA or castration; however, postoperative malaise was high, thereby masking any potential differences. Chute activity was reduced \( P < .05 \) by castration and BXA. This suggests that BXA did not result in sufficient analgesia to modify the animals' response to the castration procedure. The BXA alone also resulted in reduced chute activity and was associated with clinical sedation, muscle relaxation, and occasional (15 to 20%) difficulty in exiting the chute.

The apparent lack of analgesic action after the administration of BXA may have been associated with an insufficient dose or time period for drug effect before castration (60 s). The drug dosage and

Table 3. Least squares means of serum cortisol change\( ^a \) after castration and/or butorphanol and xylazine (BXA) administration [nmol/L]

<table>
<thead>
<tr>
<th>Day</th>
<th>Castration</th>
<th>BXA</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-20.2\textsuperscript{b}</td>
<td>10.8\textsuperscript{c}</td>
<td>-14.0\textsuperscript{b}</td>
</tr>
<tr>
<td>7</td>
<td>-14.0\textsuperscript{b}</td>
<td>10.5\textsuperscript{c}</td>
<td>-4</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Initial cortisol levels were 52 ± 32 nmol/L.

\textsuperscript{b,c}Values in a row within castration or drug not having a common superscript differ \( P < .01 \).
time allotted before surgery were predetermined based on prior clinical experience with these drugs in cattle and the procedural expediency of feedlot processing. Based on the degree of sedation and muscle relaxation achieved after the administration of BXA, higher doses would have likely resulted in a further slowing of the processing procedure and were considered inappropriate.

In a study of castration x anesthesia interaction in young swine, McGlone and Hellman (1988) found that general anesthesia resulted in the death of 28% of the pigs, and, for those that survived, anesthesia suppressed nursing behavior. The present study differs in that we were studying an analgesic x castration interaction effect in cattle undergoing normal feedlot processing procedures.

Blood cortisol levels were high (52 ± 32 nmol/L) on d 0, probably due to the stress associated with weaning and transportation. These cortisol concentrations corresponded to the "extreme stress" level of blood cortisol in cattle reported by Bennett et al. (1989). Castration and BXA increased (P < .01) cortisol levels on d 3, whereas control animals had reduced cortisol levels (Table 3). The BXA no longer had an (P > .05) influence on blood cortisol levels by d 7, but castrated calves still had elevated (P < .01) cortisol levels. This suggests that the stress of BXA did not last as long as that of castration and that the effects are independent.

The inflammatory processes induced by irritant injection or operative procedures such as castration share a common physiologic pathway in the induction of an acute phase response. The acute phase response of a host to infectious disease, environmental stress, chemical irritants, or surgical procedures is characterized by a rapid, systemic reaction to tissue injury that generally functions to restrict cellular damage and promote tissue repair. Plasma proteins such as haptoglobin are important humoral components of the acute phase response that can be used to quantify the host reaction to a variety of stressors.

Haptoglobin levels were also initially high (26.9 ± 26.7 mg of CyanBC/dL) on d 0, in parallel with cortisol values, further supporting the association of stress with the marketing process. Castration resulted in an increased serum concentration of haptoglobin on d 3, which occurred in parallel with the increased serum cortisol response (Tables 3 and 4). The kinetics and magnitude of the serum haptoglobin response to castration, determined in the present study, were very similar to those reported for an irritant-based inflammatory model in cattle. After subcutaneous injection of oil of turpentine in 3- to 4-mo-old calves, peak levels of serum haptoglobin occurred on d 3 after irritant injection, declining rapidly during the next week and returning to normal by d 11 (Conner and Eckersall, 1988).

The BXA had no effect (P > .05) on serum haptoglobin concentrations, which suggests that haptoglobin may be superior to cortisol in detecting inflammatory processes in cattle under conditions of analgesia. Serum haptoglobin may be a more specific indicator of the inflammatory process in cattle, whereas serum cortisol may be an indicator of the whole-body stress response.

Implications

Feed intake and weight gain were reduced by castration and feed intake tended (P = .13) to be reduced by the administration of butorphanol and xylazine. Cortisol and haptoglobin values confirmed that castration was stressful to the experimental animals. Butorphanol and xylazine at the doses and time sequence used in this study did not reduce stress or improve performance of castrated bull calves.

Literature Cited

Consortium. 1988. Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. Consor-


