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Effects of castration and a lidocaine-plus-flunixin treatment on growth and indicators of pain, inflammation, and liver function in Korean cattle bull calves

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ABSTRACT

The aim of this study was to determine the effects of castration and a lidocaine-plus-flunixin (LF) treatment on growth and indicators of pain, inflammation, and liver function in Korean cattle bull calves. Forty Korean cattle bull calves (body weight 197.0 ± 2.94 kg and age 6.3 ± 0.09 months) were each assigned to one of four treatments (n = 10 heads/group): no castration with no LF injection (NC-NLF); no castration with LF injection (NC-LF); castration with no LF injection (C-NLF); and castration with LF injection (C-LF). LF treatment included a local anesthetic lidocaine hydrochloride injection (12 mL of 2% in the scrotum) and intravenous injection of a non-steroidal anti-inflammatory drug, flunixin meglumine (2 mg/kg body weight of 50 mg/mL solution), immediately prior to castration. For the NLF groups, a 0.9% NaCl placebo solution was used. Castration was performed surgically using a Newberry knife and a Henderson castrating tool. Blood was collected immediately before castration and at h 0.5, h 6, d 1, d 3, d 7, and d 14 after castration. Feed intake was recorded daily, and body weight was measured on the day prior to the experiment and at d 14 after castration. Castration tended (P = 0.07) to decrease average daily weight gain, but LF treatment did not affect weight gain. Castration increased both circulating cortisol concentrations (P < 0.001) at h 0.5 after castration and substance P (SP) concentrations (P = 0.001) at h 6 after castration. However, the LF treatment did not significantly reduce cortisol and SP concentrations in castrated animals. Castration increased (P < 0.001) circulating haptoglobin (Hp) concentrations on d 1 and d 3 after castration, and LF treatment tended (P = 0.09) to decrease Hp concentrations on d 1 and decreased (P = 0.02) Hp concentrations on d 3. Castration did not affect glutamic oxaloacetic transaminase (GOT) and glutamic pyruvate transaminase (GPT) concentrations. LF treatment increased GOT concentrations at h 6 (P < 0.001), d 1 (P < 0.001), and d 3 (P = 0.003). LF treatment also increased GPT concentrations on d 1 (P = 0.006) and d 3 (P = 0.003). In conclusion, castration of bull calves resulted in time-sequential increases in circulating concentrations of cortisol at h 0.5, SP at h 6, and Hp on d 1. LF treatment did not significantly reduce elevated cortisol and SP, but tended to decrease elevated Hp concentrations in castrated animals. Our study demonstrates that LF treatment is not sufficient for the reduction of the indicators of pain and inflammation in castrated calves, suggesting that additional alleviation methods are required.

1. Introduction

Cattle are often castrated for various management purposes (Stafford and Mellor, 2005) and to improve beef quality grade through increased meat marbling (Park et al., 2002; Bong et al., 2012; Baik et al., 2015). However, castration induces stress, pain, and inflammatory responses in cattle (Warnock et al., 2012; Sutherland et al., 2013; Mintline et al., 2014).

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Local anesthetic and/or non-steroidal anti-inflammatory drugs (NSAIDs) have been used to reduce stress, pain, and inflammatory responses in cattle after castration (Sutherland et al., 2013; Webster et al., 2013). Combined treatment with both local anesthetic lidocaine and the NSAID flunixin meglumine (FM) has been effective for alleviating cortisol and behavioral responses and maintaining growth performance in surgically castrated dairy calves (Webster et al., 2013). In addition to behavioral responses, the measurement of pain and inflammation indicators may be helpful for monitoring animal welfare. FM treatment has not been effective for mitigating pain indicator substance P (SP) concentrations in cattle (Mintline et al., 2014). Direct effects of lidocaine on SP concentrations in cattle after castration have not been previously reported.

Additionally, the administration of drugs in cattle may affect liver function. However, these effects have not yet been studied. It is postulated that because surgical castration causes bleeding and activates blood coagulation, it may affect blood concentrations of calcium, a major metal involved in blood coagulation.

This study was performed to test the hypothesis that surgical castration increases SP concentrations and that the combined treatment of lidocaine (a local anesthetic) and FM (an NSAID) can effectively reduce SP concentrations in Korean cattle calves. Additionally, this study evaluated the effects of castration and drug treatment on growth, inflammatory mediators, calcium concentrations, and liver function indicators.

2. Materials and methods

All experimental procedures involving animals were approved by the Seoul National University Institutional Animal Care and Use Committees (SNUIACUC), Republic of Korea. The experiments were conducted in accordance with national guidelines provided by SNUIACUC.

2.1. Animals, treatments, and diets

Forty male Korean cattle calves (average 197 ± 2.9 kg and 6.3 ± 0.09 months of age) were used. In Korea, cattle are usually weaned at 3 months of age, transported to a new farm at 5 months of age, and bulls are castrated at 6 months of age. We followed the conventional management system of Korea for selecting the castration age for Korean cattle bulls, which was 6.3 months of age in this study. Calves were weaned at 3 months of age and fed a conventional calf starter concentrate (DM 89%, CP 17%, and TDN 70%) at approximately 1.5% of body weight and timothy hay ad libitum until 5 months of age. From 5 months of age, all calves were acclimated to the new environment and fed an experimental concentrate at approximately 1.5% of body weight and timothy hay ad libitum. Body weight was measured at -d 1 of the experiment. Calves were divided into four groups with both weight and age taken into consideration (10 heads/group) in a 2 × 2 factorial arrangement: no castration with no lidocaine-plus-flunixin injection (NC-NLF); no castration with lidocaine-plus-flunixin injection (NC-LF); castration with no lidocaine-plus-flunixin injection (C-NLF); and castration with lidocaine-plus-flunixin injection (C-LF). Each group was randomly divided into two pens (five heads/pen). All calves were housed in sawdust-bedded pens (5 m × 10 m), indoors, under a roof, and with doors installed at both sides of the barn. Water and mineral blocks were provided beside the pens, so all calves were able to drink water and intake minerals freely.

Timothy hay was provided to calves on a per-pen basis. During the first week, 10 kg (1.0% of body weight as fed base) of timothy/pen/d was provided, and all the roughage given was consumed during the first week. From the second week, 20 kg (2.0% of body weight) of timothy/pen/d was provided. Timothy orts were recorded daily. Timothy intake/pen was measured by subtracting orts from the timothy provided per pen. A concentrate of 3.0 kg/d (1.52% of body weight as fed base) was provided to each individual calf. Calves were fed timothy hay and the concentrate twice daily, at 8:00 am and 5:00 pm. An individual calf was tied in a stanchion during concentrate feeding, and calves consumed all the concentrate given. Calves had ad libitum access to water. Timothy hay consisted of 92.1% DM, 6.2% CP, and 2.1% crude fat; the concentrate consisted of 92.5% DM, 13.7% CP, and 4.8% crude fat. Table 1 lists the ingredients of the concentrate and the chemical composition of the diet. Body weight was measured again at the end of the experiment (d 14).

Table 1
Ingredients and chemical composition of diets for Korean cattle calves.

Ingredient or chemical composition	Percentage
Concentrate ingredients (DM basis)	
Ground corn	15.82
Ground wheat	18.00
Salt	0.88
Molasses	5.50
Wheat bran	3.00
Corn flour	5.00
Rice bran	3.00
Cottonseed hulls	1.50
Palm kernel meal	10.00
Ammonium chloride	0.15
Rapeseed meal	2.22
Dried distilled grain solubles	9.38
Condensed molasses solubles	1.50
Corn gluten feed	8.50
Limestone	3.30
Copra meal	10.00
Porphyry	2.00
Vitamin/Mineral premix[a]	0.25
Total	100.00
Concentrate composition	
DM	92.5
Crude ash	8.76
CP	13.7
Crude fat	4.78
ADF	12.1
NDF	27.6
ME (Mcal/kg)	2.79
TDN	74.1
Timothy composition	
DM	92.1
Crude ash	6.56
CP	6.16
Crude fat	2.11
Calcium	0.26
Phosphate	0.20
Acid detergent fiber	43.8
Neutral detergent fiber	65.9

[a] Vitamin and mineral premix contained 2,650,000 IU vitamin A, 530,000 IU vitamin D_3, 1,050 IU vitamin E, 10 g Niacin, 4.4 g Mn, 4.4 g Zn, 13.2 g Fe, 2.2 g Cu, 0.44 g I, and 0.44 g Co per kg of additive (Grobic-DC, Bayer Health Care, Leverkusen, Germany).

2.2. Castration and LF injection

During all treatments, the calves were haltered and restrained in a squeeze chute. The no castration groups were not surgically wounded because we wanted to monitor stress indicators of surgical castration. However, the calves in these groups were haltered and restrained in a squeeze chute using the same methods as those used for the castration groups. Calves receiving LF treatment (the NC-LF and C-LF groups) were administered lidocaine hydrochloride (local anesthesia agent) and FM (NSAID drug). Immediately prior to castration, the LF treatment groups received 12 mL of 2% lidocaine hydrochloride (Daihan, Seoul, Korea) via injection through a subcutaneous ring block at the neck of the scrotum, just above the testes. The LF treatment groups also received an intravenous injection of FM (2 mg/kg BW of 50 mg/mL stock solution; Fortis, Dongbang, Seoul, Korea). Calves receiving no drug