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Effect of Castration Method on Body Weight Change and Secretion of Glucose, Protein and Cortisol in Holstein Calves

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Abstract: The castration of male cattle raised for beef production is a common practice in many countries to reduce management problems such as aggressive behavior, sexual activity and dark-cutting meat. To determine the effects of the castration method on body weight change and secretion of cortisol and glucose, 27 Holstein calves (30 days old) 50.7±1.3 kg initial body weight were randomly allotted to one of three treatments: untreated Control (CON); Surgical castration (SURG) and induced Cryptorchidism (CRYP). Calves were individually fed and on the day of castration, blood samples were collected via jugular venipuncture before and every 2 h after castration for 6 h for glucose, cortisol and protein concentrations. Castration method did not influence body weight change either at 2 or 4 weeks after castration. Glucose and cortisol concentration was not influenced by castration method. Serum glucose concentration was not influenced by stressor treatment. Castration method did not influence feed intake ($p = 0.14$) and body weight change either at 2 ($p = 0.23$) or at 4 weeks ($p = 0.17$) after castration. Cortisol concentration was not influenced by castration method ($p = 0.37$). Serum glucose concentration was not influenced by stressor treatment ($p = 0.19$). Castration method did not influence serum protein concentration ($p = 0.85$). These results indicate that induced cryptorchidism is an effective method of castration in growing Holstein calves for beef production.

Key words: Performance, stress hormone, induced castration, cryptorchid, dairy bull calves

INTRODUCTION

Castration of male cattle in beef production systems is a routine practice in many countries to reduce its aggressive behavior, sexual activity (Mellor *et al*., 1991) and dark-cutting meat (Field, 1971). Raising castrated Holstein calves with refused feed by milking cows have been increasing recently. Surgical castration (Jennings, 1984) latex bands to restrict blood flow to the scrotum (Chase *et al*., 1995) and crushing the spermatic cords with a burdizzo (Robertson *et al*., 1994) are the main techniques used to castrate calves. However, male castration is related to an increase in stress hormones, like catecholamines which can raise blood sugar levels (Prunier *et al*., 2005) increased release of acute-phase proteins such as haptoglobin (Faulkner *et al*., 1992) and fibrinogen (Fisher *et al*., 1996) as an inflammatory reaction, immunological suppression and an adverse effect on performance (Molony *et al*., 1995; Fisher *et al*., 1996). Several techniques have been developed to alleviate those detrimental effects such as the use of local anesthesia (McMeekan *et al*., 1998; Earley and Crowe, 2002) anti-inflammatory drugs (Earley and Crowe, 2002; Ting *et al*., 2003) and induced cryptorchidism (Rees and Lucas, 1985). Data on physiological response to stress in Holstein calves castrated by induced cryptorchidism are very limited. Bores and Rojas reported that induced cryptorchidism in pelibuey lambs caused infertility due to testicle atrophy without stress. Therefore, the objective of this experiment was to determine the effects of different castration methods on daily feed intake, blood cortisol, glucose, protein concentrations and body weight change in growing dairy bull calves.

MATERIALS AND METHODS

The trial was conducted in the Comarca Lagunera (Francisco I. Madero, Coahuila) which is located in the North-Central part of Mexico between the parallels 24°22' and 26°23' North and meridians 102°22' and 104°47' West. The average altitude of the region is of 1,139 m. This area has mild heat throughout the year with an average temperature of 22°C and extreme dryness with an average

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rainfall of 300 mm. There is an average of 22 cold days a year with temperatures ranging lows of 0°C and highs of 40°C. Twenty seven Holstein calves 30 days old and 50.7±1.3 kg initial body weight were randomly assigned to one of three treatment groups. Each treatment group consisted of nine calves. Calves were either castrated using Surgical (SURG) or induced Cryptorchidism (CRYP) techniques or were left intact as uncastrated Controls (CON). Calves were housed in individual crates and were fed daily at 0800 h 4 L of milk substitute (SPRAYFO®) plus starter concentrate (NUPLEN®), 18.5% CP fed *ad libitum*. Fresh clean water was available at all the times. Solid feed intake was determined daily and body weight change was determined every 2 weeks until weaning (60 days). Castrations were performed by a Veterinarian. On the day of castration body weight and cross height on each calf were determined. Before castration was performed a blood sample was drawn by jugular puncture (h 0) and repeated every 2 h after castration for 6 h for analysis of glucose, cortisol and protein concentrations. Blood samples were collected into vacutainer tubes (10 mL) were centrifuged at 3000×g for 20 min at room temperature within 30 min after collection. Serum was harvested and frozen at 20°C until latter analysis. Serum samples were analyzed for glucose by a colorimetric procedure (BioSystems, Barcelona, Spain), cortisol secretion was assayed with a commercial Radioimmunoassay (RIA) and total serum protein was determined by refractometry (Rubini and Wolf, 1957).

The surgical method of castration consisted of side to side puncture of the scrotum and incision throught the ventral aspect of the scrotum from one puncture wound to the other using a knife, leaving anterior and posterior flaps of scrotal skin (Walker and Vaughan, 1980). Testicular cords and tunics were cut and removed. Induced cryptorchidism was performed by pushing the testicles of calves 2 weeks old into the body cavity and applying a rubber ring to cause atrophy of the empty scrotum. Calves become infertile due to an increase in testicular temperature while still producing the male hormone testosterone (Risbridger *et al*., 1981).

Feed intake, body weight change and feed efficiency were analyzed by analysis of variance for a completely randomized design while glucose, cortisol and protein concentrations in serum were analyzed by repeated measurements (SAS Inst., Inc., Cary, NC).

RESULTS AND DISCUSSION

Method of castration did not influence feed intake ($p = 0.14$) as shown in Table 1. Often, feed intake is decreased in animals subjected to stress. Results of this trial are different to those reported in the literature in animals subjected to different stressors. Earley and Crowe (2002) reported no effect of castration on Average Daily Feed Intake (ADFI) in calves castrated surgically from days 1-7 after surgery. However, calves castrated surgically dosed with ketoprofen (antinflammatory drug) combined with local anesthesia had lower ADFI than control calves. After days 8-14, surgery calves castrated surgically and dosed with ketoprofen and those dosed with ketoprofen plus local anesthesia had a decreased ADFI compared with control calves. No effect of castration was reported from days 15-35 on ADFI among treatments. Ting *et al*. (2003) reported no difference on DMI in bull calves before surgical castration among treatment groups. Differences in DMI among treatments did not appear until days 20-26 when all castrated animals showed a lower DMI compared with control animals. No reason for this delayed response was found by the researchers since, the incidence of morbidity was similar in the castrates compared with intact controls and the feeds offered during the trial remained consistent in quality or quantity. From days 27-33, DMI were not different among treatments. Overall from days 1-33, DMI were lower in calves castrated surgically, castrated surgically and dosed with ketoprofen before surgery and castrated surgically and dosed with ketoprofen before and after surgery compared with control calves. The results reported by Earley and Crowe (2002) were acquired with bull calves 215 kg Body Weight (BW) while those observed by Ting *et al*. (2003) were with bull calves of 300 kg B.W. and 11 months of age. Calves used in this trial were young (30 days old) and lighter (50.7 kg B.W.) than those used by Earley and Crowe (2002) and Ting *et al*. (2003). Robertson *et al*. (1994) reported that the stress caused by surgical catration increase as the age increase.

Average daily gain was not different ($p = 0.17$) among treatments. Stresses caused by castration increases with age in calves, so older animals are more stressed than those castrated 1 week after birth. Corbett *et al*. (1973) found no differences in growth rates of the induced

Table 1: Mean voluntary feed intake, body weight change and feed efficiency in holstein calves castrated by different methods

	Treatment[1]				
Items	CON	CRYP	SURG	p-values	SEM[2]
Feed intake (g day^{-1})	1384.60	1382.30	1692.60	0.14	149.00
Body weight change (g day^{-1})	675.80	697.70	730.20	0.17	95.00
Feed conversion ratio (g g^{-1})	2.04	1.98	2.31	0.80	0.14

[1]CON = Control (uncastrated); CRYP = Induced Cryptorchidism; SURG = Surgical Castration; [2]SEM = Standard Error of Mean, n = 9

cryptorchidism and those of castrated males in lambs 1-2 weeks old. Warnock *et al.* (2012) reported that calves castrated pre-weaning (52 days) showed higher feed intake than bull calves castrated post weaning averaging 454 kg in weight. Hudson *et al.* (1968) reported that lambs submitted to induced cryptorchidism gained faster than wethers and were equal to rams in gain due to leaner carcasses. Ting *et al.* (2003) found a lower ADG from days 1-7 in castrated animals compared with those in the control group. Overall, from days 1-33 ADG was lower in bull calves castrated surgically than in uncastrated animals. Calves used in this trial were six times lighter than those used by Ting *et al.* (2003) which could explain the contradictory results. Pushing the testis of lambs 1-2 weeks old into the body cavity and applying a rubber ring to cause atrophy of the empty scrotum did not prevent most testes growing in a subcutaneous position.

Serum cortisol concentrations prior castration was similar and averaged 7.2, 6.9 and 8.0 ng mL^{-1} for CON, SURG and CRYP, respectively. The 2 h after castration, cortisol concentrations increased 0.3, 2.1 and 4.7 ng mL^{-1} for CON, SURG and CRYP, respectively. About 6 h after castration cortisol concentration in all calves returned to those values found prior castration. Overall, serum cortisol concentration was not affected ($p = 0.28$) by castration method (Fig. 1) and averaged 7.2, 6.9 and 8.0 ng mL^{-1} for CON, SURG and CRYP, respectively. King *et al.* (1991) examined the effect of age and method of castration on plasma cortisol in calves castrated at 78±12 or 167±14 days of age by burdizzo or surgical methods and reported no difference in plasma cortisol concentration between surgical and burdizzo calves at 3 h post treatment but higher concentrations for surgically castrated calves at 6 h.

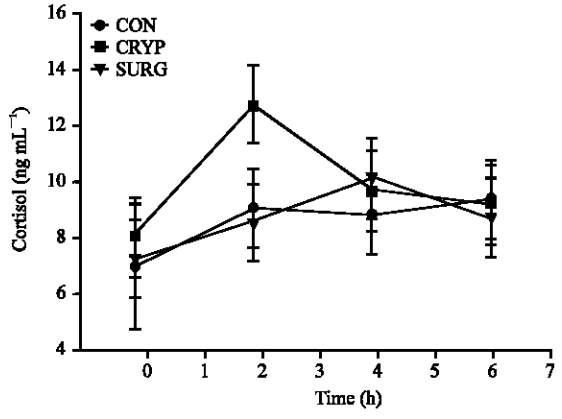

Fig. 1: Mean±SE cortisol concentration for Holstein bull calves left uncastrated (CON), Surgically Castrated (SURG) or submitted to induced Cryptorchidism (CRYP, n = 9/group)

Stress induces metabolic changes and several researchers have reported differences in hormone secretion related with stress in animals. Fisher *et al.* (1996) and Earley and Crowe (2002) found an increase in cortisol in castrated bull calves. Chase *et al.* (1995) reported that serum concentration of cortisol prior to surgery were similar between treatments and averaged 16.1, 16.6 and 15.3 ng mL^{-1} for uncastrated castrated surgically and castrated by latex rubber banding, respectively. However, cortisol concentration increased in bull calves castrated surgically but not in those castrated by latex rubber banding immediately after castration. After 2 days, castration increases in cortisol were similar between bull calves castrated surgically but not in those castrated by latex rubber banding treatments and both were higher than uncastrated controls. Cohen *et al.* (1990) found an increase in plasma cortisol at 3 and 6 h after castration in surgically castrated Holstein calves. Castration by burdizzo or surgical methods elicited an increase in plasma cortisol which remained elevated for up to 8 h following castration (Fisher *et al.*, 1996). Johnston and Buckland (1976) reported increased plasma corticoid concentrations 15 min, 24 and 48 h after castration of 4 months old calves. Robertson *et al.* (1994) reported an increasing cortisol response to castration with increasing age in Ayrshire calves castrated at 6, 21 or 42 days of age. King *et al.* (1991) obtained similar results in calves castrated at 78 or 167 days of age regarding to cortisol secretion. Peak values of cortisol secretion in young pigs occurred between 30 and 60 min after castration. Cortisol then returned to presurgery levels within 3 h (Prunier *et al.*, 2005). Results of this trial agree with the consortium developing the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching which recommended that bulls be castrated at as early an age as possible and that calves older than 2-3 months of age be administered a local anesthetic during castration (Consortium, 1988). Serum glucose concentration was not affected ($p = 0.19$) by castration method as shown in Fig. 2. Kannan *et al.* (2000) reported a similar trend in glucose and cortisol concentration just prior to slaughter in goats. Glucose secretion in animals submitted to stress is increased due to the hepatic glycogen breakdown (Murray *et al.*, 1990). The absence of an increase in glucose secretion after castration could be explained by an insufficient storage of hepatic glycogen in young pigs (Prunier *et al.*, 2005). Sanhouri *et al.* (1992) noted that as a response to stress elevation of glucose concentration was preceded by an elevation of cortisol concentration in stressed goats by transportation. Kannan *et al.* (2003) reported a higher cortisol, glucose and nonesterified fatty acids concentration in stressed goats than in control goats.

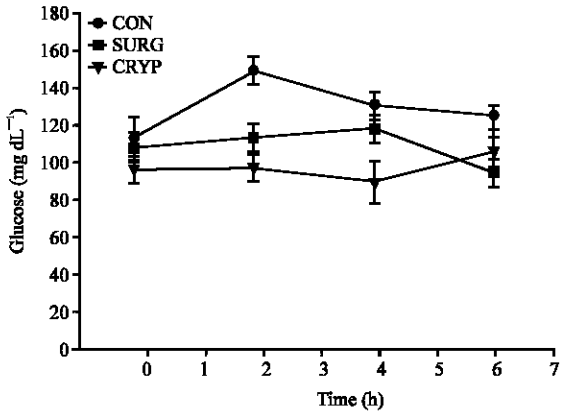

Fig. 2: Mean±SE glucose concentration for Holstein bull calves left uncastrated (CON), Surgically Castrated (SURG) or submitted to induced Cryptorchidism (CRYP, n = 9/group)

Serum protein concentration was similar (p = 0.85) among treatments and averaged 5.5, 5.6 and 5.7 g dL^{-1} of total protein for SURG, CRYP and CON, respectively. Warnock *et al.* (2012) reported unimportant numerical differences in serum protein (ceruloplasmin and haptoglobin) concentration in bull calves castrated by different methods compared to control bull calves castrated prior weaning and minimal differences among castration methods. However, Bretschneider (2005) found higher levels of serum protein in bull calves castrated by surgical procedure.

CONCLUSION

The results of the present study indicate that induced cryptorchidism in young Holstein calves induce a stress in a similar fashion than surgical castration. Therefore, taking into consideration that induced cryptorchidism avoids practical disadvantages that may be encountered in raising entire male calves, it is an uncomplicated and bloodless method that could be used as a routine management in calves raised for meat production in dairy farms. Animal performance is not affected by induced cryptorchidism in young calves.

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