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Effect of Hemicastration Performed at Various Ages on Body Weight, Testicular and Epididymal Growth in Bull Calves.

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Abstract

he effect of hemicastration performed at various ages of bull calves, on testicular growth was studied in 27 animals. emicastration (HC) was performed from 10 to 190 days of age at monthly interval and the contralateral testis removed 0 days later. The bulls being hemicastrated served as controls (I) for the animals being castrated at that age. Body weight 3W), testicular weight (TW), epididymal weight (EW) and the relative weight (organ weight/body weight) of testis (RTW) nd epididymis (REW) was determined every 60 days between 70-250 days. Body weight did not differ with treatment $P<0.05$), but increased with age from 40 to 250 days ($P<0.05$). TW, EW and REW were not influenced by treatment at ny age ($P<0.05$). RTW of HC animals based on single testis, differed from that of I ($P=.02$) when hemicastration was erformed at 70 days. The testis of HC bulls gained 178 per cent vs. 86 per cent in I during 70-130 day period. RTW did ot differ between HC and I animals in other age groups ($P>0.05$). The epididymides of HC animals grew at a faster rate han that of I animals when hemicastration was performed at day 100 (92 vs. 67%) and at day 130 (74 vs. 31%) during he following 60 days.

ntroduction

eonatal hemicastration results in hypertrophy of remaining stis in rate (Grant, 1957; Liang and Liang, 1970; Setchell nd Waites, 1972; Gomes and Jain, 1976; Cunningham *et* ., 1978; Johnson and Neaves, 1983), ram (Land and Carr, 975; Waites *et al.*, 1983), boar (Swiestra and Rahnfeld, 968; Kosco, 1986), rabbits (Lipschutz, 1922); and bulls Barnes *et al.*, 1980; Al-Haboby, 1986). However, emicastration of individuals produced conflicting results hen hemicastration of adult rats (Shallabarger, 1963; ndgren *et al.*, 1976; Cunningham *et al.*, 1978), adult bbits (Lipschutz, 1922; Edwards, 1940), adult dogs (Kyrle *al.*, 1911) and adult bulls (Hochereau-de Reviers, 1970) iled to result in compensatory hypertrophy of the maining testis. Ramirez and Sawyer (1974) in adult rats, oglmayr and Mattner (1968); Land and Carr (1975); ochereau-de Reviers *et al.*, (1976, 1984) in adult rams, nd Johnson and Dillard (1975); Johnson (1978); Boockfor *al.*, (1983) in adult bulls, observed a significant ypertrophy of remaining testis. Hemicastration performed 3 months of age resulted in greater degree of ompensatory hypertrophy in bulls compared with emicastration at 6 or 9 months (Boockfor *et al.*, 1983). perm production in intact bulls is related to testicular size Macmillan and Hafz, 1968a). Bulls with hypertrophied stes following hemicastration have higher sperm oduction per testis than intact bulls (Barnes *et al.*, 1980a; oockfor *et al.*, 1983).

igher conception and calving rate, and a lower age at first reeding has been reported in cows sired by bulls with rger testes (Coulter and Foote, 1979; Toelle and obinson, 1985). Systematic morphometric study of the ffects of hemicastration has been reported only following neonatal hemicastration (Al-Haboby, 1986), on the remaining testis and epididymis. The objectives of this study, therefore was to determine the response of testis and epididymis following hemicastration performed at monthly interval from days 10 to 190 of life.

Materials and Methods

Animals: Twenty seven Holstein bull calves from the University of Minnesota herds were used. The calves sucked their dams within one hour after birth and thus fed on colostrum. Thereafter, they were weaned and housed in individual pens and raised on milk or sour colostrum until the age of 28 days. They were allowed a free choice of water, grain and hay from 4 days of age. After 28 days, bull calves were confined to a semiclosed barn and fed alfalfa, straw, corn and silage *ad libitum*.

Experimental Design: A total of 27 bull calves were used and randomly assigned at birth so that 3 were to be hemicastrated (HC) at each of eight times: 10, 40, 70, 100, 130, 160 or 190 days of age. At hemicastration, the right testes were removed and used for determination of values for intact (I) bulls. The remaining left testes were removed (castration) 60 days subsequent to respective hemicastration and compared to the right testes removed at that age from calves being hemicastrated. The bulls were weighed at the time of hemicastration and castration. The testes and epididymides were separated from extraneous material and weighed as described under "organ weight".

Surgical Procedure: Surgical procedures for castration were carried out under general anesthesia using xylazine (Rompun, Bayvet Division, Cutter Laboratories, Inc.,

hawnee, Kansas, U.S.A). All animals were kept off feed or 12-18 hours prior to surgery. Every animal was ositioned on the side and the scrotum was exposed by ulling the upper limb forward. An antiseptic sudsing skin leanser (Betadine) was applied to clean the scrotum and urrounding abdominal area. A dorsal surgical incision was nade along the longitudinal axis of the testis, through the kin, tunica dartos and tunica vaginalis exposing the testis. Precaution was taken not to damage the testicular surface. An appropriately sized injection needle was introduced and positioned in the straight portion of testicular artery on the esticular surface. A chromic gut suture appropriate for the ize of the spermatic cord in individual animals (size 00-3) vas applied around the spermatic cord, proximal to the pampiniform plexus, tied securely and the spermatic cord was cut distal to the ligature. The stump was a sprayed with 4 per cent furazolidone (Veterinary Products Lab, Phoenix, Arizona), checked for bleeding and the wound left unsatured. The testis was perfused with Ringers solution via the arterial canula to remove all the blood and then by 4 per cent glutaraldehyde in 2M S-collidine buffer at 180 mm Hg for later histological study. Testes were handled with great care during perfusion and processing thus securing tissue integrity to the extent possible.

Organ Weight: The extraneous tissue was removed from the testes and epididymides and the organs weighed. The testicular weight (TW), epididymal weight (EW), relative weight (organ weight/body weight) of the testes (RTW) and the epididymides (REW) were recorded.

Statistical Analysis: Statistical Analysis System (SAS) was used to analyze body weight, testicular weight (TW), relative testicular weight (RTW), epididymal weight (EW), and relative epididymal weight (REW) in all age groups. Analysis was performed as a randomized complete block with a following statistical model:

$$Yij = u + Ti + Dj + (TD)ij + eij$$

where

Yij = the individual observation of a specific treatment and age
u = overall mean
Ti = effect of ith treatment
Dj = effect of jth day
(TD)ij = interaction term
eij = random error term

Whenever there was a statistical difference, Duncan's multiple range test (Duncan, 1955) was used for comparison of means. T-test was done to compare the difference at each age group.

Results

Effect of Hemicastration of 10 Day Old Bull Calves: The right testis of an I animal averaged 4.46 g at 10 days of age and that of another group of I bulls averaged 10.6g (183 per centmore) at 70 days. After hemicastration, the testis weight increased from an average of 4.46g to 8.36g (87%) during 10-70 days period. Corresponding epididymis and body weights of I bulls were .18g and 44.5 kg 10 days and 1.99 (155 per centmore) and 68.1 kg (53 per centmore) at 70 days, respectively, whereas 60 days post-hemicastration, the epididymis weight increased from .08g to 1.69g (117 per centincrease) and body weight increased from 44.5 kg to 63.1 kg (42 per centincrease) in the same period. The body weight (BW), TW, EW, RTW, and REW were not different between HC and I animals at 70 days of age ($P<0.05$). (See tables I through VI).

Effect of Hemicastration of 40 Days Old Bull Calves: The right testis and epididymis of I animals averaged 5.3g and .08g at 40 days of age and those of another group of I bulls averaged 16.9g (218 per centmore) and 2.4g (215 per centmore) at 100 days. Following hemicastration, the testis weight and epididymis weight increased from an average of 5.3 to 15g (183%) and .08g to 1.7g (129%) during 40-100 days period, respectively. The average body weight of 40 day old I was 50.3 kg and of 100 days old I was 106.4 kg (111 per centmore). After hemicastration, the body weight increased from 50.3 per centkg to 71.1 kg (41%). The BW, TW, EW, RTW, and REW did not differ between I and HC animals at 100 days of age ($P<0.05$).

Effect of Hemicastration of 70 Days Old Bull Calves: The right testis and epididymal weight of intact animals averaged 10.6g and 1.9g at 70 days, and those of another group of I bull calves averaged 19.8g (86 per centmore) and 3.0g (49 per centmore) at 130 days. After hemicastration, TW and EW increased from an average of 10.6g to 29.4g (178%) and 1.9g to 2.9g (48%), during 70-130 days. Body weight of I bull calves averaged 68.1 kg at 70 days and 118.9 kg (51 per centmore) at 130 days. After hemicastration, the body weight increased from 68.1 kg to 101.4 kg (49%) during 70-130 days. The BW, TW, and REW did not differ between I and HC animals at 130 days of age ($P<0.05$). The RTW of HC was more than that of I at 130 days of age ($P=.02$).

Effect of Hemicastration of 100 Day Old Bull Calves :The right testis and epididymis of I animals averaged 16.9g and 2.4g and that of another group of I bulls weighed 41.5g (145 per centmore) and 3.9g (67 per centmore) respectively at 160 days. After hemicastration, the testicular and epididymal weights increased from an average of 16.9g to 50.5g (198%) and 2.4 to 4.5g (92%) during the period of 100-160 days, respectively. The body weight of I animals averaged 106.4 kg at 100 days and 157.4 kg (48 per centmore) at 160 days of age. After hemicastration, the body weight increased from 106.4 kg to 162.1 kg (52%) during 100-160 days. BW, TW, EW, RTW, and REW did not differ between I and HC animals at 160 days of age ($P<0.05$).

Effect of Hemicastration of 130 Day Old Bull Calves: The

able 1: Body weight ($\bar{x} \pm$S.E) of intact (I) and hemicastrated (HC) bulls.

ge (Days)		Wt. (KG)		AT HC	Wt. (KG)		AT C WT (KG)OF I AT TIME OF C	
T HC	AT C	Mean	S.E.		Mean	S.E.	Mean	S.E.
)	70	44.5	3.9		63.2	2.7	68.1	6.5
)	100	50.3	3.8		71.1	3.3	106.4	14.9
)	130	68.1	6.5		101.4	15.1	118.9	0.7
0	160	106.4	14.9		162.1	3.2	157.4	14.5
0	190	118.9	0.7		148.6	5.5	159.7	7.3
0	220	157.4	14.5		200.1	12.4	165.8	11.8
0	250	159.7	12.7		194.3	34.5	217.6	3.9

= Hemicastration : Removal of right testis
= Castration : Removal of contralateral testis 60 days post hemicastration
= Intact : The right testis removed and used for comparison for the bulls being castrated
ree animals in each treatment group

ble 2: The means of body weight of all treatment groups from 10-250 days of age

ys of age	10	40	70	100	130	160	190	220	250
an weight(g)	44.54	50.33	65.68	88.74	110.16	154.15	159.29	182.91	208.27

ne means underscored with a line do not differ among each other at P = .05.

le 3: Testis weight and relative testicular weight (RTW, testis weight/body weight) of intact (I) and hemicastrated (HC) bulls (x ± S.E).

tomical	Age (days)		Weight at HC		Weight at C		Weight of I at the age of C	
racteristic	At HC	At C	Mean	S.E	Mean	S.E	Mean	S.E
	10	70	4.7	1.41	8.40	0.7	10.6	2.3
	40	100	5.3	1.23	15.00	3.3	16.9	3.4
	70	130	10.6	2.30	29.40	6.9	19.8	1.8
is weight (g)	100	160	16.9	3.40	50.50	4.9	41.5	8.3
	130	190	19.8	1.80	46.40	8.3	51.4	5.6
	160	220	41.5	8.30	89.60	13.2	75.8	20.6
	190	250	51.4	5.60	93.10	15.5	105.9	10.3
	10	70	0.9	0.28	1.30	0.15	1.15	0.24
	40	100	1.1	0.23	2.10	0.39	1.6	0.11
ive testi-	70	130	1.5	0.24	2.8a	0.31	1.7b	0.14
r weight	100	160	1.6	0.11	3.10	0.34	2.6	0.32
$(x10^4)$	130	190	1.7	0.14	3.10	0.79	3.2	0.26
	160	220	2.6	0.32	4.40	0.41	4.4	1.67
	190	250	3.2	0.26	4.80	0.05	4.8	0.39

= Hemicastration : Removal of right testis
Castration: Removal of contralateral testis 60 days post hemicastration
ntact: The right testis removed and used for comparison for the bulls being castrated
eans in the same row with different letter differ ($P<0.05$)

4:The means of testes weight of all treatment groups from 10-250 days of age

of age	10	40	70	100	130	160	190	220	250
weight(g)	4.46	5.33	9.48	15.96	24.60	45.10	48.90	82.70	100.78

means underscored with a line do not differ among each other at P = 0.05.

Table 5: Epididymis weight and relative epididymal weight (RTW, testis weight/body weight) of intact (I) and hemicastrated (HC) bulls ($\bar{x} \pm$ S.E).

Anatomical characteristic	Age (days) At HC	At C	Weight at HC Mean	S.E	Weight at C Mean	S.E	Weight of I at the age of C Mean	S.E
Epididymis weight (g)	10	70	0.80	0.10	1.70	0.15	1.90	0.75
	40	100	0.80	0.10	1.70	0.15	2.40	0.55
	70	130	1.90	0.75	2.90	0.52	3.00	0.46
	100	160	2.40	0.55	4.50	0.13	3.90	0.86
	130	190	3.00	0.46	5.20	0.43	3.80	1.43
	160	220	3.90	0.86	6.50	0.64	5.70	1.46
	190	250	3.80	0.81	6.20	1.16	6.90	1.02
Relative epididymal weight ($x10^4$)	10	70	0.17	0.01	0.26	0.02	0.28	0.10
	40	100	0.14	0.01	0.24	0.02	0.21	0.02
	70	130	0.28	0.10	0.28	0.02	0.25	0.04
	100	160	0.21	0.02	0.27	0.05	0.25	0.05
	130	190	0.25	0.04	0.34	0.00	0.24	0.04
	160	220	0.24	0.05	0.32	0.02	0.33	0.06
	190	250	3.20	0.04	0.31	0.00	0.32	0.05

HC = Hemicastration : Removal of right testis
C = Castration : Removal of contralateral testis 60 days post hemicastration
I = Intact : The right testis removed and used for comparison for the bulls being castrated

Table 6: The means of epididymal weight of all treatment groups from 10-250 days of age

Days of age	10	40	70	100	130	160	190	220	250
Mean weight(g)	.07	.07	1.84	2.04	2.95	4.20	4.52	6.12	6.62

* The means underscored with a line do not differ among each other at P = .05.

average right testicular and epididymal weights of I animals were 19.8g and 3g at 130 days of age and those of another group of I animals at 190 days of age were 51.4g (160 per centmore) and 3.8g (31 per centmore) respectively. After hemicastration, the testicular and epididymal weights increased from an average of 19.8g to 46.4g (134%) and 3g to 5.2g (74%) during the period of 130-190 days of age. The body weight of I animals averaged 118.9 kg at 130 days and 159.7 kg (34 per centmore) at 190 days of age whereas after hemicastration, the body weight increased from an average of 118.9 kg to 148.6 kg (25%) during 130-190 days period. The BW, TW, RTW, EW and REW did not differ between I and HC animals at 190 days of age ($P<0.05$).

Effect of Hemicastration of 160 Day Old Bull Calves: The right testis and epididymis of I animals weighed an average of 41.5g and 3.9g at 160 days and those of another group of I animals averaged 75.8 (83 per centmore) and 5.7g (43 per centmore) at 220 days of age. After hemicastration, the testis and epididymal weights increased from 41.5g to 89.6g (116%) and 3.9g to 6.5g (64%) during the period of 160-220 days of age. The body weight of I animals averaged 157.4 kg at 160 days and 165.8 kg (5 per centmore) at 220 days of age, whereas in hemicastrated animals, it increased from 157.4 kg to 200.1 kg (27%) during 160-220 days period. The BW, TW, RTW, EW and REW did not differ between I and HC animals at 220 days of age ($P<0.05$).

Effect of Hemicastration of 190 Day Old Bull Calves: The right testis and epididymis of I animals averaged 51.4g and 3.8g at 190 days of age and those of another group of I animals averaged 105.9g (104 per centmore) and 6.9g (78 per centmore) at 250 days of age. After hemicastration testis and epididymal weights increased from 51.4g to 93.1g (81%) and 3.8g to 6.2g (60%) during 190-250 days period. The body weight of 190 day old bull calves was 159.7 kg and that of 250 days old I bull calves was 217.6 kg (36 per centmore) whereas after hemicastration it increased from 159.7 kg to 194.3 kg (22%) during 190-250 days of age. The BW, TW, RTW, EW and REW did not differ between I and HC animals at 250 days of age ($P<0.05$).

Discussion

Body weight in both I and HC animals of all age groups increased in a similar fashion as reported by McCarthy *et al.* (1979a), Barnes *et al.* (1980a), Curtis and Amann (1981), Haboby (1986), and hemicastration at any age did not affect this pattern.

Neonatal hemicastration of bulls (Barnes *et al.*, 1980

ooby, 1986) and hemicastration performed at 3 months rnes *et al.*, 1983; Boockfor *et al.*, 1983), at 6 and 9 nths (Boockfor *et al.*, 1983), and of puberal and adult bulls nnson, 1978), did result in compensatory hypertrophy. mpensatory hypertrophy of testis was not observed in ually mature bulls by Hochereau-de Reviers (1970).

s data demonstrated that hemicastration performed at any between 10-190 days did not result in the compensatory ertrophy of the contralateral testis or epididymis in the owing 2 months with the exception of bulls hemicastrated 0 days of age, when RTW of HC bulls was higher at 130 s of age compared with that of intact controls. Though nificant differences were not observed in testicular and didymal weights two months following hemicastration ween HC and I animals, the rate of testicular growth was ier in HC animals hemicastrated at 70 days and 100 days 3 per centand 198%) than the I controls (86 per centand %). The epididymis likewise grew at a higher rate in HC nals than I of the same age when HC was performed at days (92 vs. 67%) and 130 days (74 vs. 31%). The s weight increase of 18.8g during 60 days in HC animals icastrated at 70 days compared with 9.16g in the I trols during the same period suggests that hemicastration ormed at 70 days of age may have resulted in significant ertrophy if the post hemicastration period was increased 2 months. The failure to see compensatory hypertrophy I groups may in general be due to lessor post HC period. aboby (1986), did not observe any compensatory ertrophy till 100 days of age after neonatal hemicastration all other studies mentioned above have observed the ct of hemicastration more than 100 days post icastration.

onclusion, hemicastration performed at 10 to 190 days of does not result in compensatory hypertrophy of the aining gonad in following two months. To observe the ct of hemicastration at any age, a period of more than 60 s may be require

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