Testicular compensation in Nguni (*Bos indicus*, Sanga) bulls with unilateral gonadal hypoplasia and aplasia

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The testosterone response to gonadotropins in Nguni bulls with unilateral gonadal hypoplasia and aplasia was studied. Despite having one grossly affected or totally absent testis, the residual testicular tissue was found to be able to maintain a normal basal serum testosterone concentration, and to yield a normal response to PMSG with respect to peak testosterone value and peak response time. It is possible that this compensation is responsible for the maintenance of fertility of bulls with gonadal hypoplasia as observed by other workers.

Die testosteroonreaksie vir gonadotrofiese hormone in Ngunibulle met unilaterale hipoplasie en totaal-unilateraal-afwesige teelbal is bestudeer. Ten spyte van een klein of 'n totaalafwesige teelbal was die bestaande teelbalweefsel in staat tot die normale basale serumtestosteroonkonsentrasie sowel as 'n normale reaksie vir DMSG met betrekking tot die piektestosteroonwaardes en -tyd. Dit is moontlik dat hierdie kompensasie verantwoordelik is vir die onderhouding van vrugbaarheid in hierdie diere soos waargeneem deur ander werkers.

Keywords: Hypoplasia, testosterone, PMSG, compensation

Gonadal hypoplasia is a genetic trait owing to a single recessive gene with approximately 50% penetrance (Eriksson, 1950). Manifestation of this gene in the bull is in the form of varying degrees of underdevelopment of one or both testes. A study carried out by Lagerlöf (1951) involving 10 000 cattle showed that the unilaterally affected animals have normal fertility, while the bilaterally affected animals have reduced fertility or total infertility. Gonadal hypoplasia has been reported in numerous breeds of cattle including Swedish Highland Cattle (Lauvergne, 1970), Shorthorn, Ayrshires, Frieslands, Herefords (Laing & Young, 1956) and the Nguni (Pretorius & Osbourn, 1979).

The present study was carried out on the Nguni, a *Bos indicus* breed, indigenous to the north-eastern coastal areas of South Africa, to establish the capacity of affected bulls to respond to an intravenous gonadotropin challenge.

Nine 1-year-old Nguni bulls were selected from the Bartlow Combine nucleus breeding herd in KwaZulu. The animals were divided into three groups, each containing three animals. Animals in Group I demonstrated normal testicular development, those in Group II demonstrated unilateral gonadal hypoplasia and those in Group III demonstrated unilateral gonadal aplasia. Allocations were based on the results of palpation and measurement of the length of the testes. The animals were kept on the veld without additional supplements. The average mass of the bulls at 12 and 17 months of age was 189 kg and 244 kg respectively.

The bulls were subjected to two gonadotropin challenges, the first at the age of 12 months and the second at the age of 17 months. The challenges were carried out according to Cox, Kiser, Dunlap, Rampacek & Kraeling (1981), except that 2 000 IU PMSG (Seragon, Sweden) was administered instead of 200 μg LH. Blood samples were collected −30, −15, 9, 15, 30, 45, 60, 120, 150 and 180 minutes after intravenous injection of PMSG. Serum samples were stored at −20°C until assayed for testosterone. Total unconjugated serum testosterone was quantitated using a non-extraction, I-125 tracer double antibody radioimmunoassay having 3,4% and 0,6% cross-reaction with 5 α-dihydrostestosterone and 5 β-dihydrostestosterone respectively (Radioassay Systems Laboratories, California). Samples from the stimulations at 12 months and 17 months were analyzed in the same assay. The precision of the assay was determined according to Ekins, Newman, Piyasena, Banks & Slater (1972). The relative error was < 10% for serum testosterone concentrations > 0,4 ng/ml.

The lengths of the palpated testes at the age of 12, 15 and 18 months are given in Table 1.

The mean testicular lengths of the unaffected sides of Groups II and III were not significantly different from the mean lengths of Group I. The mean testicular lengths of the affected sides of Group II and III were significantly different ($P < 0{,}01$) from the means of the contralateral side as well as the means of Group I.

The mean testosterone responses to PMSG for the three groups on the two occassions are shown in Figure 1 (A) and (B).

Table 1 Mean (± SD) length of testes of Nguni bulls of Group I (normal), Group II (unilateral hypoplastic), and Group III (unilateral) aplastic) at various ages

	Mean testicle length (cm) in:				
	Group I	Group II		Group III	
Age (months)	Average of both testes	Unaffected side	Affected side	Unaffected side	Affected side
12	9,6 ± 0,5 ($n = 6$)	10,3 ± 1,2 ($n = 3$)	4,3 ± 1,2 ($n = 3$)	11,6 ± 1,5 ($n = 3$)	0 ($n = 3$)
15	10,3 ± 0,9 ($n = 6$)	11,0 ± 1,0 ($n = 3$)	4,6 ± 2,1 ($n = 3$)	12,0 ± 1,0 ($n = 3$)	0 ($n = 3$)
18	12,6 ± 0,5 ($n = 6$)	11,3 ± 1,5 ($n = 3$)	6,0 ± 4,6 ($n = 3$)	11,3 ± 0,6 ($n = 3$)	0 ($n = 3$)

n = Number of testicles measured

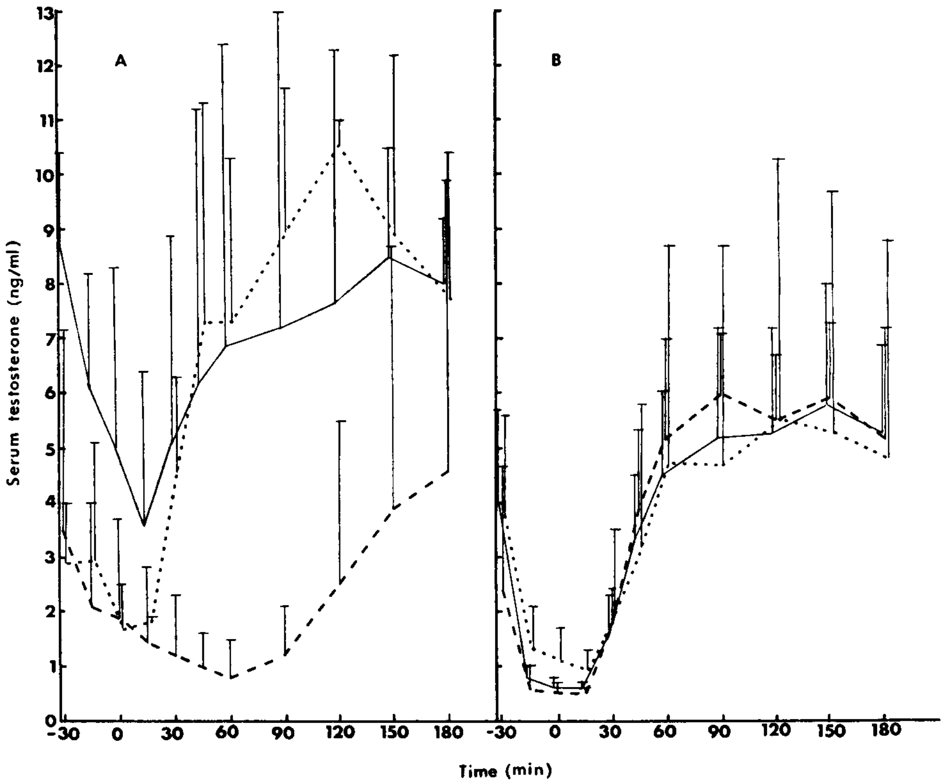

Figure 1 Mean (± SD) testosterone response curves at 12 months (A) and 17 months (B) for normal (________), unilateral hypoplastic (-----), and unilateral aplastic (..........) animals

Table 2 Mean (± SD) basal testosterone, peak testosterone, and interval from treatment to maximum testosterone values for the three groups of Nguni bulls at different ages

Age (months)	Group	Basal testosterone (ng/ml)	Peak testosterone (ng/ml)	Peak time[a] (min.)
12	I	5,0 ± 3,3	8,5 ± 2,0	150
	II	1,9 ± 1,8	4,6 ± 5,3	180
	III	1,7 ± 0,8	10,6 ± 0,4	120
17	I	0,6 ± 0,2	5,8 ± 2,2	150
	II	0,5 ± 0,2	6,0 ± 1,1	90
	III	1,1 ± 0,6	5,5 ± 4,8	120

[a]Interval from treatment to maximum testosterone value

Three characteristics of the testosterone response were used for comparative purposes, namely, the zero time testosterone concentrations, the maximum testosterone concentration, and the interval from treatment to maximum testosterone value (Table 2).

There was no significant difference between Groups I and II, I and III, and II and III for any of the three response parameters.

Despite the unilaterally hypoplastic and aplastic bulls having significantly less total testicular tissue than the normal animals of Group I, the characteristics of the response curves of Group II and III were not significantly different from the normal in any respect at ages of 12 and 17 months. As the unaffected testes in animals of Groups II and III were not significantly longer than those of animals in Group I, it would appear that the residual testicular tissue has compensated to the degree that not only can normal basal values be maintained but a normal testosterone response to a PMSG challenge can also be achieved. Basal testosterone levels and testosterone responses to PMSG in the normal and abnormal Nguni bulls are similar to values obtained by other authors working on normal (Kiser, Milvae, Hafs, Oxender & Louis, 1978; Cox *et al.*, 1981) and hemicastrated bulls (Barnes, Boockfer, Bierly, Kazmer, Halman & Dickey, 1981). Basal serum testosterone concentrations for normal bulls in the present study were 5,0 ± 3,3 and 0,6 ± 0,2 ng/ml at 12 and 17 months of age respectively as compared to 7,6 ± 2,4 and 2,5 ± 0,5 ng/ml (Kiser *et al.*, 1978) and 1,8 ± 0,2 ng/ml (Cox *et al.*, 1981). Basal testosterone values for Group II and Group III bulls were 1,9 ± 1,8 (12 mo) and 0,5 ± 0,2 (17 mo) and 1,7 ± 0,8 (12 mo) and 1,1 ± 0,6 ng/ml (17 mo) respectively as compared to 2 ng/ml obtained by Barnes *et al.*, 1981 in hemicastrated bulls. In the present study, maximum testosterone concentrations in response to PMSG for normal bulls were 8,5 ± 2,0 (12 mo) and 5,8 ± 2,2 ng/ml (17 mo) as compared to 15,9 ng/ml (Kiser *et al.*, 1978) and 5,9 ± 0,5 ng/ml obtained by Cox *et al.*, 1981. Maximum testosterone concentrations achieved by animals in Group II were 4,6 ± 5,3 (12 mo) and 6,0 ± 1,1 ng/ml (17 mo) and by those in Group III 10,6 ± 0,4 (12 mo) and 5,5 ± 4,8 ng/ml (17 mo), which are similar to the 9 ng/ml obtained by Barnes *et al.* (1981) in hemicastrated bulls in response to GnRH. The interval between gonadotropin injection and maximum testosterone values for Groups I, II and III at both 12 and 17 months of age was greater than 2 hours except for Group II at 17 months where the interval was 1,5 hours. The intervals are marginally longer than the intervals of 1,75 hours demonstrated by Kiser *et al.* (1978) and 1,5 hours demonstrated by Cox *et al.* (1981). The hemicastrated bulls in the study by Barnes *et al.* (1981) demonstrated maximum testosterone values approximately 1,5 hours after GnRH administration.

From the present study and from results obtained by Barnes *et al.* (1981), it is clear that the testis of the bull is capable of compensation, at least as far as testosterone output is concerned, for a diminished or totally absent contralateral testis. Although the fertility of the hypoplastic bulls was not assessed in this study, the normality of the testosterone basal levels and response to PMSG complement the findings of Lagerlöf (1951) and Lagerlöf & Settergren (1961) who indicated that bulls with unilateral gonadal hypoplasia have unimpaired fertility.

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