American Journal of Primatology 26:309–314 (1992)

BRIEF REPORT

Endocrine and Developmental Correlates of Unilateral Cryptorchidism in a Wild Baboon

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A wild, group-living 8.5-year-old adult baboon was found to have only a single palpable testicle, the only case of cryptorchidism found among more than 200 males that we have examined. This young adult had an unusually small body size for his age, one that was comparable to that of immature males two years younger, and during maturation his body mass was increasingly small for his age. As a young adult, he also had very low testosterone concentrations, which, in combination with his small size, history of impaired growth, and the absence of any obvious scars around the scrotum, suggest that this is a case of spontaneous unilateral cryptorchidism of unknown cause rather than one of monorchidism arising from injury. Despite striking differences in his growth, adult body size, and testosterone levels, the male's cryptorchidism seemed to have relatively little effect on his social and sexual maturation in his natal group. Nonetheless, it may be related to his inability to gain entry into another group after dispersal.

Key words: baboons, social maturation, physical maturation, testosterone

INTRODUCTION

During physical examination of 62 free-living male yellow baboons, *Papio cynocephalus,* under anesthesia, one young adult, an eight-and-a-half-year-old, was found to have only a single palpable testicle. This was the only observed case of cryptorchidism, failure of testicular descent, in this population, and the only one noted by RMS during studies that included testicular palpation of approximately 200 additional male yellow and olive baboons in other populations. In order to evaluate likely causes and consequences or correlates of the unilateral cryptorchidism, we present here comparative analyses of the male's prior physical and social development and of morphometric and endocrine evaluations made at the time of examination.

Cryptorchidism occurs in approximately 0.7% of adolescent and adult humans [Griffin & Wilson, 1985]. It results from a variety of physiological or anatomical

Received for publication March 4, 1991; revision accepted May 30, 1991.

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failures, and is of unknown etiology in most cases. Whether other physical or behavioral abnormalities are associated with the cryptorchidism usually depends on the cause. For example, reduced androgen levels are occasionally seen and are generally thought to reflect the malfunction that produced the cryptorchidism rather than the cryptorchidism itself [Griffin & Wilson, 1985]. The consequences of such instances of reduced androgen secretion might include impaired growth. Androgens are well-known for their effects on pre- and peri-pubescent growth in mammals [reviewed in Underwood & van Wyke, 1985]. Some of the effects of testosterone on growth are growth hormone-dependent, in that testosterone can enhance stimulated GH release [Martin et al., 1968; Illig & Prader, 1970]. Other effects involve direct anabolic actions at the muscle, such as stimulation of glucose transport [Max & Toop, 1983].

METHODS

The present research was conducted on yellow baboons in Amboseli National Park in southern Kenya. All members of three main study groups are identified visually by individual physical characteristics and have been part of longitudinal, observational research projects. The histories of the males born into these study groups are known since birth [see, e.g., Altmann et al., 1988] from daily records on demography, reproductive cycles, social interactions including agonistic, grooming, and sexual behavior, and monthly evaluations of physical maturation, including extension of permanent canines beyond the tooth row and the rounding of the scrotum that occurs after rapid testicular growth during puberty [see Altmann et al., 1981, 1988]. Starting in 1984, ontogenetic changes in body mass were monitored through periodically placing an unbaited scale near a frequented site and then recording data when animals voluntarily used the scale [see Altmann & Alberts, 1987, for details]. Periodic censuses of other groups in the area and frequent checks for lone males in a large number of identified sleeping trees provide data on the whereabouts of males that emigrate from groups [Samuels & Altmann, 1991].

During 1989 and 1990, the hands-off observational work was supplemented by morphometric measurements and collection of blood samples during a short period of anaesthetization. Subjects were anaesthetized with Telazol (tiletamine hydrochloride and zolazepam), approximately 250 mg/male, injected from a propelled syringe that was fired from a blowgun at 10 meters. Animals were darted only when they were out of the sight of other baboons and when their backs were turned, so as to preclude anticipatory stress or loss of habituation. All subjects were darted between 7:30 AM and 10:30 AM to control for circadian fluctuations in hormone values.

A first blood sample was obtained at the earliest time that we could safely bleed subjects and always within 15 minutes of darting [see Sapolsky, 1982, and Sapolsky & Altmann, 1991, for details]; the lag-time for obtaining the sample from Noggin, the male in question, fell well within this range. Telezol is a relatively new anaesthetic, but its tiletamine hydrochloride component is structurally similar to Sernylan (phencyclinadine hydrochloride). The latter drug has been well-characterized, and does not affect testosterone concentrations in baboons during this time period [Sapolsky, 1982]. Samples were centrifuged on site and plasma frozen in dry ice until returned to the United States. Radioimmunoassay of testosterone was conducted as published previously [Gay & Kerlan, 1978]. Antiserum S250 generated in sheep was used against a testosterone-11-bovine serum albumin conjugate. Testosterone is the main androgen in baboons; small amounts of androstenedione and dehydroepiandrosterone [Snipes et al., 1969] also occur, but cross-reactivity of the antiserum with either of these androgens is less than 1%. Coefficients of vari-

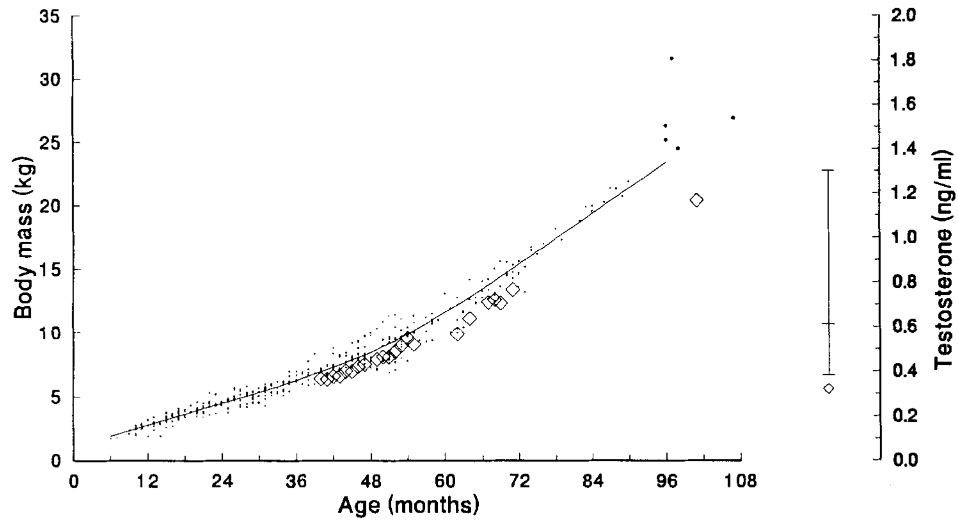

Fig. 1. Body mass of males .6–9 years old (left), and testosterone levels for adult males (right); see text for details. Diamonds (large for body mass, small for testosterone) indicate data for Noggin, the male with cryptorchidism; small closed circles indicate the data for other males. The line shown for maturing males is the LOWESS-smoothed curve, which uses robust locally weighted regression [Cleveland, 1979], for all males, including Noggin. Median and quartile values are given for testosterone for all adult males.

ation across and within assay were 0.08 and 0.04, respectively (n = 3). Each animal was weighed, skeletal measurements were taken, dental emergence and eruption were evaluated, and permanent canines and testicles were measured for male subjects.

RESULTS

Noggin was eight-and-a-half years old (3,027 days) when examined. Upon palpation of his scrotum for measuring testicular volume, we located only a single testicle, the right one, which was of normal size. There was no indication of any scrotal wounding or other pathology. Noggin's testosterone concentration (0.32 ng/ml) was half that of the five other 8–9-year-old males and below the 25th percentile for the full set of 26 adult males (including Noggin) for whom we have data (Fig. 1). Only three other group-living males, two of which were very old and in poor health, had values lower than Noggin. Values for all other endocrine determinations (cortisol, cholesterol, glucose, insulin) were unremarkable (unpublished data).

At the time of examination, Noggin's body mass, 20.4 kg, was 4–5 kg less than that of his age peers and comparable to that of subadult males two years younger (Fig. 1). His long-bone measurements were even further retarded, by an additional six months. All other 8–9-year-olds, but not younger males, had complete dentition, including all third molars, and canines that were of full length. Noggin's canines were of full length, but one of his third molars had not yet erupted. Although Noggin's small body size had been noted by observers for several years, no abnormalities had been suspected, and visual evidence of a missing testicle, which might have been apparent in the pendulant testes of older males, had not been detected by this age.

A six-year longitudinal study of body-mass growth, recently completed at the time of this clinical evaluation, includes records for Noggin on 55 days scattered among ages 40–71 months, throughout the second juvenile stage and into early subadulthood [Altmann et al., 1981]. Comparative data were available for 24 other males in the two wild-foraging groups during at least some parts of the same age span. Using deviation scores from a LOWESS locally weighted regression [Cleveland, 1979], we found that in each of the 21 months for which we have data Noggin was light for his age. For every one of the 21 months, Noggin was the lightest for that age in his own social group, and during most months (all of the ages greater than 55 months) he was also lighter than all males from the other wild-foraging group as well. At 71 months (early subadulthood) Noggin weighed 13.4 kg, 1–2 kg less than his age peers (Fig. 1). Noggin experienced an adolescent growth spurt (as judged by a statistically significant quadratic component in regression fit to his longitudinal mass data) as is characteristic for males, but one that was 18th of 24 in magnitude for males in the wild-foraging groups.

Noggin attained all but one developmental marker of morphological and social maturity later than the median age, but he was not an outlier on any (23rd of 28 males for slight testes rounding and 25/39 for full rounding, 4/16 for protrusion of the permanent canines past the tooth row, 13/16 for attainment of a dominance status within the adult male class, and 7/12 for consortships with estrous females). Noggin consorted with three different adult females in his natal group during a total of four different estrous cycles before his dispersal, and was a likely father for one pregnancy [see Altmann et al., 1988, for a description of determination of likely fathers]. His age for dispersal from the natal group was 13th of 19 males. The only behavioral measure on which Noggin was an outlier was elapsed time between departure from the natal group and entry into another group, for which he was 11th or 12th of 12 males (he was still living alone at the time of this writing, December 1990). Although he spent time in proximity to three baboon groups after his dispersal, Noggin failed to enter any of them and was chased vigorously and repeatedly by adult males from at least two of them.

DISCUSSION

A wild, group-living adult baboon who was found to have only a single palpable testicle had small body size, had been increasingly small for age as a juvenile and subadult, and had a very low basal concentration of testosterone. These findings allow us, with some degree of confidence, to identify this as a case of spontaneous unilateral cryptorchidism, rather than monorchidism arising from injury.

In the latter case, when a testis is lost to injury at some time during development, there is considerable potential for compensation by the remaining testis. Typically, there is hypertrophy and hyperplasia of Leydig cells in the remaining testis; because such cells account for only approximately 10% of the testis mass, such compensation is rarely discernible when gross testis size is measured. Nevertheless, these compensatory changes are usually sufficient to normalize testosterone concentrations and, secondary to that, growth [Griffin & Wilson, 1985].

In contrast, in cases of spontaneous unilateral cryptorchidism at birth, these compensations are rarely observed and, instead, testosterone concentrations, linear growth, and muscle mass are attenuated. In general, this lack of compensation by the second testis is interpreted as implying underlying pathology; that is, whatever dysfunction eliminated the missing testis impaired the remaining one as well. Spontaneous cryptorchidism in humans can arise from a variety of causes, including primary malformation of a testis, blockage of the inguinal canal, or insufficient abdominal pressure to push the testis into the scrotum [reviewed in Scorer & Farrington, 1979].

Although our developmental and endocrinological data suggest that the present case is one of spontaneous unilateral cryptorchidism, we note that the testosterone data must be interpreted cautiously, since only single determinations were made on each of these free-living baboons. In addition, because LH determinations were not made on these animals, we are unable to determine whether its concentrations were normal for Noggin, and whether the low testosterone concentrations were associated with altered LH feedback sensitivity. We also note that the testosterone levels found for adults in this study are, in general, lower than those previously reported for olive baboons by RMS [e.g., Sapolsky, 1982]. Although this may represent a species difference between yellow and olive baboons, another possibility lies in the finding [Sapolsky, 1986] that testosterone concentrations were lower for his animals in a drought year; Amboseli's habitat is appreciably drier than that of the Mara and the present study was conducted during the latter half of the dry season both years.

Despite major differences in growth, adult body size, and testosterone levels, Noggin's cryptorchidism seemed to have little effect on his social and sexual maturation in his natal group. The strongest apparent deviation from normal behavior was associated with adult immigration. Although Noggin was able to function as a normal adult male within his natal group, he was not able to do so in another group.

Among cercopithecine primates, high levels of aggression toward immigrants have frequently been reported, even when levels of aggression toward them had been low in their natal group [see review in Pusey & Packer, 1987]. Nonetheless, the aggression does not typically prevent eventual entry into the new group. The ability to resist such aggression is probably an important component of successful immigration. A second key ingredient of successful immigration appears to be the development of affiliative relationships with adult females [Strum, 1982; Dunbar, 1984; Smuts, 1985]. Noggin's small body size may have compromised both his ability to resist aggression from other adult males in the new group and his ability to form affiliative relationships with adult females; adult females may not have perceived this subadult-sized male as an adult, and may therefore have avoided forming affiliative relationships with him. Consequently, although Noggin had the normal behavioral repertoire of an adult male baboon, ultimately his small body size may have prevented him from expressing that normal repertoire among unfamiliar adults.

CONCLUSIONS

1. Small adult body size, history of impaired growth, low testosterone concentrations, and absence of scars around the scrotum were used to identify a case of spontaneous unilateral cryptorchidism of unknown cause rather than one of monorchidism arising from injury in a wild-living, young adult male baboon that had only a single palpable testicle.
2. The male's cryptorchidism was not associated with major differences in his social and sexual maturation within his natal group despite the striking differences in growth, adult size, and testosterone levels; nonetheless, it may be related to his difficulty in gaining entry into another group after dispersal.

ACKNOWLEDGMENTS

We are grateful for sponsorship, assistance, or permits in Kenya to the Office of the President, Republic of Kenya, to the Kenya Wildlife Services, its Amboseli staff and wardens, and its Director, R. Leakey, and to the Institute of Primate Research, its staff, and its former and present directors, J. Else and M. Isahakia.

The field work further depended directly on a number of people in Kenya, especially S. Altmann, D. Chai, R. Eley, R. Kones, P. Muruthi, R.S. Mututua, G. Reid, S. Sayiallel, K. Snyder, L. Share, J. Somen, and M. Suleman. L. Gale prepared the figure; she and L. Moses consulted on statistical analysis of the growth data. Financial support for the field work was provided by the L.S.B. Leakey Foundation and Sigma Xi, and the University of Chicago Hinds Fund (S.C.A.), Harry Frank Guggenheim Foundation (R.M.S.), and the Chicago Zoological Society (J.A.). This manuscript was prepared while J.A. was a Fellow at the Center for Advanced Study in the Behavioral Sciences where financial support was provided by the John D. and Catherine T. MacArthur Foundation; logistic support was generously and graciously provided by the Center staff.

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