The Action of Prolactin on the Sex Accessory Glands of the Male Rat (36923)

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Unlike the situation in the female mammal, where there are important reproductive functions for the anterior pituitary hormone prolactin, few functions have been reported for this hormone in the male mammal. Bartke (1) has reported that the hormone acts synergistically with LH in hypophysectomized mice to restore spermiogenesis. Prolactin also increases the activity of 3β-hydroxysteroid dehydrogenase in the testes of dwarf mice (2), and synergizes with LH in hypophysectomized rats to increase the blood level of testosterone above that found either with LH alone or in the normal animal (3). In addition, prolactin synergizes with testosterone to increase the weight of the ventral (4–6) and dorsolateral prostate (7, 8) of the rat. The seminal vesicles have also been found to increase in weight in response to prolactin acting either synergistically with testosterone (5, 9, 10), or independently (11, 12). As a result of the synergism of prolactin and testosterone there is an increase in the fructose and citric acid content of the dorsolateral prostate (7, 8), seminal vesicles, and coagulating gland (9). However, there are no reports of prolactin affecting the prostate in the absence of testosterone.

The purposes of the experiments reported in this paper were to reinvestigate the prolactin–testosterone synergism on the weight of sex accessory glands and to determine the prolactin effect on the functional activity of the prostate.

Materials and Methods. Sprague-Dawley rats, either raised at the Department of Animal Science, University of California, Davis, CA, or purchased from Simonsen Laboratories, Gilroy, CA, were housed in air-conditioned quarters with a 14 hr light, 10 hr darkness lighting regime. The rats were castrated between 28 and 30 days of age under ether anesthesia. Unless otherwise noted all treated rats received 100 μg of testosterone propionate in peanut oil, subcutaneously every other day from 40 to 48 days of age. In addition, prolactin-treated rats received daily injections of 300 μg of ovine prolactin[3] intraperitoneally from 40 to 49 days of age. Autopsies were performed at 50 days of age.

Tissue for zinc analysis was ashed at 600° in Viscan crucibles and dissolved in 5.0 ml of 0.36 *N* HCl at 75°, cooled for 30 min, and the zinc was determined by a Perkin-Elmer atomic absorption spectrophotometer No. 403.

The study of the 24 hr uptake of ^{65}Zn was performed initially as described by Gunn and Gould (13). In this procedure $^{65}ZnCl_2$ in HCl solution is neutralized with 0.5 *N* NaOH and diluted with 0.9% NaCl. Each rat received 0.4 μCi/g body weight at 49 days of age by intracardiac injection. The following day the rats were autopsied and the tissues were weighed and counted in a Nuclear Chicago Model 4216 well gamma counter.

When we attempted to confirm the results of the above experiment, it was found that a precipitate formed when the $^{65}ZnCl_2$ solution was neutralized. Therefore, in the second experiment reported in Table IV (last 3 groups) the $^{65}ZnCl_2$–HCl solution was simply

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TABLE I. Effect of Testosterone Propionate (TP) and Prolactin (PL) on the Wet Weights of the Seminal Vesicles and Ventral Prostate.

Castrate	Treatment	*N*	Tissue	Wet wt (mg)
+	TP	7	Seminal	46.8 ± 5.67[a]
+	TP + PL	6	vesicles	53.4 ± 5.00
+	TP	7	Ventral	37.9 ± 5.79
+	TP + PL	6	prostate	42.6 ± 6.34
+	TP	9	Ventral	94.3 ± 5.69
+	TP + PL	7	prostate	80.1 ± 6.50
+	TP	5	Ventral	79.2 ± 11.31
+	TP + PL	6	prostate	84.1 ± 4.58
+	TP	6	Ventral	94.9 ± 9.88
+	TP + PL	6	prostate	95.4 ± 8.00
+	TP	6	Ventral	111.5 ± 11.20
+	TP + PL	6	prostate	102.2 ± 6.79
+	—	9	Seminal	18.0 ± 0.97
—	—	7	vesicles	355 ± 34.0
+	—	9	Ventral	14.5 ± 0.56
—	—	7	prostate	259 ± 20.6

[a] Mean ± SEM.

diluted with 0.9% NaCl and 0.2 μCi/g body weight was slowly injected.

Results and Discussion. There is no indication that prolactin significantly increases the effect of testosterone on the weights of the seminal vesicles and ventral prostate (Table I). However, in one of four experiments recorded in Table II the prolactin-treated group had significantly heavier dorsolateral prostates ($p < .05$), and in two experiments the dorsolateral prostates of the prolactin group were significantly heavier on a per gram body weight basis ($p < .05$ and $p < .02$, respectively). Prolactin did not affect either the dry weight or the percentage of dry weight to wet weight of the dorsolateral prostate in the two experiments where measured. Comparison of prolactin plus testosterone vs testosterone groups for all experiments by analysis of variance shows that there was a significant effect on the wet weight ($p < .05$) and wet weight per gram body weight ($p < .05$).

The zinc contents of the dorsolateral prostates of the animals in the last three experimental groups listed in Table II were determined (Table III), and in the first group prolactin was found to have increased the concentration of zinc on both a wet weight and dry weight basis ($p < .02$), while in the second group the hormone significantly increased the zinc content of this gland ($p < .05$) but not the concentration. Comparison, by analysis of variance, of prolactin plus testosterone vs testosterone groups for both experiments revealed that there was a significant prolactin effect on the zinc content per gland ($p < .005$).

Experiments were conducted to determine if prolactin, in the absence of testicular androgens, would increase the uptake of ^{65}Zn by the dorsolateral prostate. The results are summarized in Table IV. In the first experiment prolactin significantly increased the uptake of ^{65}Zn per gland ($p < .05$). There was no increase in the weight of the dorsolateral prostate, but ^{65}Zn uptake per unit wet weight for the prolactin group was not significantly different from that of the control group. In the second experiment prolactin increased both the uptake of ^{65}Zn per gland ($p < .02$) and per unit wet weight ($p < .01$) for the dorsolateral prostate, but did not affect the wet weights of either the dorsolateral or ventral prostate, or the seminal vesicles, or the ^{65}Zn uptake of the latter two glands.

The results of our experiments on the synergism of prolactin and testosterone in

increasing the weight of the dorsolateral prostate confirm the results reported by Grayhack (7) and Grayhack and Lebowitz (8). The fact that addition of prolactin did not significantly increase the dry weight of this tissue beyond that caused by testosterone alone might suggest that prolactin causes either an increase in the water content of the gland or a retention of prostatic secretion. However, neither of these suggestions explains why the percentage of dry weight to wet weight is not significantly altered by prolactin treatment. Grayhack and Lebowitz (8) were of the opinion that secretion retention was not the cause since increases in content and concentration of citric acid and fructose resulting from prolactin–testosterone treatment did not parallel one another.

Although there is no indication that the zinc in the secretions of the rat dorsolateral prostate is necessary for adequate reproductive performance (14, 15), zinc concentration and uptake appear to be a specific indicator of the activity of the dorsolateral prostate. This gland has a very high zinc concentration (16) and selectively concentrates ^{65}Zn (17). It has previously been shown that castration and certain doses of estrogen decrease, and testosterone increases ^{65}Zn uptake by the rat dorsolateral prostate (13), and Gunn, Gould and Anderson (18) have reported that prolactin will synergize with luteinizing hormone or testosterone to increase the 24 hr uptake of ^{65}Zn by the dorsolateral prostate. Our observation that prolactin, when given with testosterone, increases the zinc content in this gland supports the contention that the prolactin–testosterone synergism increases the functional activity of the dorsolateral prostate.

The finding that prolactin, by itself, can increase the uptake of ^{65}Zn by the dorsolateral prostate of the castrated rat is the first indication that prolactin has an effect on this gland independent of testosterone. This result is at odds with a report by Gunn and Gould (19) that treatment of hypophysectomized rats with 200 or 500 μg prolactin did not increase the 24 hr uptake of ^{65}Zn. This discrepancy may result from strain differences or from a difference in the sensitivity of

TABLE II. Prolactin–Testosterone Synergism on the Weight of the Dorsolateral Prostate.

Castrate	Treatment	N	Wet wt (mg)	Wet wt/g body wt	Dry wt (mg)	(Dry wt/wet wt) × 100
+	TP	5	44.6 ± 3.01[a]	0.190 ± 0.006	—	—
+	TP + PL	6	56.7 ± 4.12[b]	0.234 ± 0.016[b]	—	—
+	TP	6	47.2 ± 3.75	0.187 ± 0.016	—	—
+	TP + PL	6	53.3 ± 2.51[b]	0.208 ± 0.009[b]	—	—
+	TP	6	69.9 ± 8.55	0.272 ± 0.036	10.56 ± 1.27	15.16 ± 0.33
+	TP + PL	6	74.3 ± 5.68[b]	0.295 ± 0.020[b]	11.23 ± 1.01	15.29 ± 0.58
+	TP	9	65.2 ± 15.09	0.213 ± 0.013	9.83 ± 0.76	15.09 ± 0.32
+	TP + PL	9	77.5 ± 15.40[b]	0.265 ± 0.018[b]	11.75 ± 0.74	15.18 ± 0.18
—	—	4	149.1 ± 25.30	0.521 ± 0.086	21.89 ± 3.59	14.74 ± 0.14
—	—	6	16.9 ± 0.80	0.069 ± 0.004	1.95 ± 0.03	11.57 ± 0.56

[a] Mean ± SEM.

[b] Analysis of covariance indicates a significant effect ($p < .05$).

TABLE III. Prolactin–Testosterone Synergism on the Zinc Content of the Dorsolateral Prostate.

Castrate	Treatment	N	Zinc (μg) per: Gland	100 mg wet wt	100 mg dry wt
+	TP	6	4.11 ± 0.68[a]	5.74 ± 0.36	37.6 ± 2.4
+	TP + PL	6	5.38 ± 0.43[b]	7.29 ± 0.37	47.2 ± 2.0
+	TP	9	4.36 ± 0.33	6.86 ± 0.56	45.7 ± 3.8
+	TP + PL	9	6.47 ± 0.85[b]	8.28 ± 0.94	54.3 ± 5.7
—	—	4	17.1 ± 5.2	10.48 ± 1.71	71.5 ± 44.0
+	—	6	ND[c]	ND	ND

[a] Mean ± SEM.
[b] Analysis of covariance indicates a significant treatment effect ($p < .005$).
[c] ND = not detectable (<2.5 μg/gland).

TABLE IV. Effect of Prolactin on the Uptake of ^{65}Zn by the Sex Accessory Glands.

N	Castrate	Treatment	Gland[a]	Wet wt (mg)	^{65}Zn (cpm) per: Gland	Mg wet wt
9	+	Saline	DLP	8.2 ± 0.85[b]	1969 ± 387	245 ± 26
7	+	Prolactin		8.4 ± 1.16	5197 ± 1259[c]	674 ± 180
9	+	Saline	DLP	29.9 ± 1.72	1478 ± 149	49 ± 10.5
7	+	Prolactin		26.3 ± 2.32	3133 ± 577[d]	119 ± 18.4[e]
7	—	—		154 ± 9.6	17857 ± 2803	228 ± 24.5
9	+	Saline	VP	14.5 ± 0.56	748 ± 72	48 ± 6.5
7	+	Prolactin		14.6 ± 0.86	831 ± 72	57 ± 3.5
7	—	—		259 ± 20.6	12900 ± 417	51 ± 5.8
9	+	Saline	SV	18.0 ± 0.97	794 ± 33	45 ± 8.2
7	+	Prolactin		19.3 ± 1.60	1037 ± 143	52 ± 3.9
7	—	—		355 ± 34.0	17508 ± 1639	50 ± 2.8

[a] DLP = dorsolateral prostate, VP = ventral prostate, and SV = seminal vesicles.
[b] Mean ± SEM.
[c] Prolactin vs saline, $p < .05$; [d] $p < .02$; [e] $p < .01$.

the gland in the hypophysectomized animal.

Summary. Prolactin synergizes with testosterone to increase the wet weight of the dorsolateral prostate of the rat and the functional activity of this gland, as indicated by an increase in zinc content. Prolactin, in the absence of testicular androgens, increased the uptake of zinc by the dorsolateral prostate.

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