INFLUENCE OF HORMONES ON ACCESSORY SEX GLANDS IN MALES

E. UMAPATHY, S. MANIMEKALAI AND P. GOVINDARAJULU

Department of Endocrinology,
Postgraduate Institute of Basic Medical Sciences, Taramani, Madras

Summary: Administration of testosterone, oestrogen, progesterone and prolactin for seven days affected the epididymal lipids markedly whereas seminal vesicular and prostatic lipids were less affected. The increase in total lipids of caput epididymis by testosterone, oestrogen and progesterone was due to an elevation in neutral and phospholipid contents. However, progesterone alone caused an increase in total lipids of the cauda epididymides while oestrogen and prolactin decreased the same. In seminal vesicle and prostate, testosterone elicited a significant rise in total lipids. However, an opposite trend was obvious by the other three hormones. Testosterone alone was effective in elevating the total lipids, phospholipid, cholesterol and glycerides in prostates. Prolactin does not affect the prostatic lipids markedly. The significance of the lipid changes are discussed in relation to various physiological activities of sex accessories.

Key words: testosterone, progesterone, oestrogen, prolactin, male sex accessories, lipids

INTRODUCTION

Lipids form the major secretory products of epididymis besides sialoproteins and the concentration of phospholipids is generally highest in caput epididymides of many species (1). This and the fact that phospholipids may either serve as a substrate for spermatozoa during their epididymal m turation or as a source of glyceryl phosphoryl choline (2) suggests the possibility of importance of lipids in the physiological activities of accessory sex glands. Major amount of lipids in semen is contributed by prostate (3) and seminal vesicle, the formation and m tabolic turnover of phospholipids in these glands, depend on androgenic stimulation (4). This could mean that the hormone-lipid interrelationship may also exist in accessory sex glands. The present long-term studies were aimed to establish the lipid-hormone interrelationship in accessory sex glands, and to associate the lipid changes in relation to physiological milieu of the sex accessories. The short-term effects of similar studies have already been reported (5).

MATERIALS AND METHODS

Male albino rats (100-110 days old, 190-200 *g* body weight) of Wistar Strain were used for the present investigations. They were maintained in a well ventilated animal house with free access to water and a standard balanced diet. They were divided into the following five groups, each consisting of 10 animals.

Group I — Testosterone propionate, 1 *mg*/100 *g* body weight/day.
Group II — Progesterone, 1 *mg*/100 *g* body weight/day.

Group III — Prolactin, 0.5 *mg*/100 *g* body weight/day.

Group IV — Oestradiol, 17 β, 6 μg/100 *g* body weight/day.

Group V — Served as controls and received only the vehicle (pea nut oil). The route of administration was intramuscular for a period of seven days. The optimum dosage as reported by earlier workers have been made use of in the present study.

The animals were sacrificed by cervical dislocation on the eighth day. Caput and cauda epididymides, seminal vesicle, and all lobes of prostate were removed immediately, freed from adhering tissue, rinsed, blotted and weighed accurately on a torsion balance, for further processing.

Total lipids were extracted from the tissue by a mixture of chloroform: Methanol (2:1, v/v). The extract was evaporated at 45°C under nitrogen. The residue was dissolved in chloroform: M thanol (2:1, v/v) containing 4% of water, to break the proteolipid bonds. The mixture was evaporated under nitrogen at 45°C and the same process was repeated for three times. The residue was again dissolved in chloroform; Methanol (2:1, v/v), equilibrated with 0.9% sodium chloride for seven to eight hours, to remove glycolipids. The chloroform: Methanol layer was evaporated and the total lipid was estimated by the method of Folch *et al.* (6). The method of Tschugaeff as modified by Hanel and Dam was used to estimate total cholesterol (7). Phospholipids were determined as phospholipid phosphorous. The inorganic phosphorous was determined by the method of Bartlett, as modified by Marinetti (8) and multiplied by a factor 25 (9). The level of significance between the treatment groups were calculated by Students 't' test which was processed in IBM 1620 computer.

RESULTS

Table Ia presents alterations in the lipid classes of the caput epididymides due to hormonal influence. The increase in total lipids induced by progesterone ($P<0.001$) was mainly due to an increase in phospholipids. Progesterone and oestrogen markedly stimulated the glycerides ($P<0.001$). However, prolactin did not elicit significant changes. Table Ib represents the fluctuations in the lipid classes of cauda epididymides. Progesterone caused an increase in glycerides ($P<0.001$), and a decrease in phospholipids ($P<0.05$). Prolactin caused a decrease in glycerides ($P<0.001$). Testosterone did not aff ct the content of the total lipids but increased the total phospholipids ($P<0.001$). Oestrogen decreased all the parameters studied.

Save for testosterone, all the hormones administered drastically reduced all the classes of lipids in seminal vesicles ($P<0.001$). Testosterone effectively raised the total lipids, which was chiefly due to phospholipids and glycerides (Table IIa).

In prostate, as in seminal vesicles, testosterone evoked an increase in total lipids, phospholipids, cholesterol and glycerides ($P<0.001$). Progresterone and oestrogen brought about a decrease in glycerides ($P<0.001$). A small increase in phospholipids ($P<0.05$) was also observed in progesterone, oestrogen and prolactin treatment (Table IIb).

TABLE I: Influence of hormones on epididymal lipids.

Parameters	*Control*	*Testosterone*	*Progesterone*	*Oestradiol*	*Prolactin*
TABLE Ia : *Lipid pattern — Caput Epididymis*					
Total Lipid	99.4±20.3	134.3±22.3*	169.2±24.9**	132.9±21.8*	107.5±10.8
Total phospholipid	14.4± 1.2	19.8± 2.1*	28.0± 3.0**	20.1± 2.3*	13.1± 1.8
Total Cholesterol	12.5± 1.0	12.8± 0.9	16.7± 1.3**	13.5± 0.9*	12.7± 0.9
Total Glycerides	72.5±14.3	101.7±16.8**	124.5±18.3**	99.3±13.8**	81.7±10.4
TABLE Ib : *Lipid pattern — Cauda Epididymis*					
Total lipid	71.2±10.2	74.2±11.3	94.7±13.8**	64.9±10.3	51.7± 9.2**
Total phospholipid	12.0± 1.0	18.0± 0.5**	10.2± 1.2*	11.7± 1.3	13.4± 1.4
Total Cholesterol	13.0± 1.0	13.2± 1.3	14.3± 1.8	11.4± 0.9*	12.4± 1.2
Total Glycerides	46.2±10.2	43.0±11.8	70.2±15.3**	41.8± 9.3	25.9± 7.3

* $P<0.05$

** $P<0.001$

All the values are expressed as *mg/g* tissue.
Results are Mean ± SD of 10 animals per group.

DISCUSSION

Caput epididymis: Lipids form the major secretory products of epididymis besides sialoproteins (1). Testosterone was found to enhance the weight of epididymis due to hypertrophy and hyperplasia (10). Increase in total lipids of epididymis seems to depend on a number of factors of which the influence of androgens is quite significant ((11). Testosterone might influence the epididymis by its conversion to dihydrotestosterone (12). The action of testosterone and oestrogen by increasing the total lipids may be due to increased synthesis of phospholipids as has been shown in accessory sex glands (13). Accumulation of glycerides may be due to increased esterification of acyl groups as a consequence of increased metabolic activities. The effect of oestrogen on epididymis seems to be anabolic as that of testosterone.

TABLE II: Influence of hormones on accessory sex gland lipids.

Parameters	*Control*	*Testosterone*	*Progesterone*	*Oestradiol*	*Prolactin*
TABLE IIa : *Lipid pattern — Seminal vesicle*					
Total lipids	87.7± 5.8	100.2± 6.3**	61.3± 4.3**	60.3± 4.8**	62.1± 5.2**
Total phospholipid	20.3± 2.8	24.9± 3.2*	13.8± 1.2**	15.4± 2.3**	15.5± 1.2**
Total Cholesterol	18.7± 0.9	18.9± 1.2	13.9± 0.9**	12.9± 1.2**	13.8± 0.8**
Total Glycerides	48.7±10.3	56.4±10.8	33.6± 7.2*	32.0± 8.3*	32.8± 9.6*
TABLE IIb : *Lipid pattern — prostate*					
Total lipids	46.9± 8.7	72.8± 6.3**	40.2± 9.2	38.5± 7.3**	46.6± 8.4
Total phospholipid	13.6± 1.2	20.1± 1.8**	14.8± 1.3	15.2± 1.8	12.7± 1.3
Total cholesterol	12.8± 0.8	14.0± 0.3**	13.1± 0.7	12.9± 0.9	12.9± 0.8
Total glycerides	20.5± 1.2	48.7± 9.3**	12.3± 1.2**	10.4± 0.5**	21.0± 3.4

* $P<0.05$
** $P<0.001$

All the values are expressed as *mg/g* tissue.
Results are Mean ± SD of 10 animals per group.

The accumulation of glycerides may be due to the anti-androgenic effect of progesterone as has been shown earlier (14). The impaired sperm maturation due to progesteronic influence (15) could have also resulted in the non-utilisation of glycerides. Androgenic potency of progesterone (17) could have led to the synthesis of phospholipids and cholesterol due to increased cellular metabolic activity. The synergistic action of exogenous progesterone along with endogenous testosterone might have reflected in the accumulation of phospholipids ($P<0.001$) and cholesterol ($P<0.001$).

Cauda epididymis: Though prolaction does not evoke any marked alterations in caput, it is found to decrease the total lipids by decreasing the glycerides and it may be concluded that prolactin might possibly have an influence in the cauda epididymis. Progesterone is the only hormone which is found to alter the lipid metabolism in both caput and cauda epididymides. The differential responses elicited by the different segments of epididymis may be due to their structural, functional and hormonal activit es, as reported in our short-term studies (5).

Seminal vesicle: Testosterone induces the growth of membraneous structures of seminal vesicles (4), thereby leading to an increase in the weight and synthesis of

lipids as well. It is interesting to note that they were decreased due to oestrogen, progesterone and prolactin influence. It may be tempting to suggest that lipids may be considered as an index of androgenic activity in seminal vesicles but further correlated studies are needed. An earlier response by lipids to oestrogen was found to be stimulatory (16) but under prolonged treatment, it is inhibitory. The decrease in lipids in seminal vesicles in progesterone treated group may confirm the earlier suggestion that synthetic progestogen inhibit the overall metabolic phenomena in seminal vesicles (14). The decrease in all the classes of lipids in prolactin treatment may be due to decreased secretory activity.

Prostate: Testosterone was found to stimulate the weight and the secretion of prostate (17). The increase in lipids due to testosterone influence may reflect the increase in membrane permeability of the tissues as well as synthesis of mitochondrial membrane structure (18). Oestrogen has been reported to inhibit the testosterone induced enzymes in ventral prostate (19) due to the competition for receptor sites between oestrogen and testosterone, in prostate (20) which may be the reason for the decreased lipid synthesis in prostate. Progesterone treatment also led to a decreased glyceride concentration due to its anti-androgenic action in prostate. Prolactin did not evoke any marked response.

ACKNOWLEDGEMENTS

Our thanks are due to National Institute of Health, Bethesda, Maryland, for the gift sample of Prolactin. One of us (E. Umapathy) is grateful to Indian Council of Medical Research, New Delhi, for the award of Junior Research Fellowship, during the tenure of which the work was carried out.

REFERENCES

1. Hafez, E.S.E. and M.R.N. Prasad. In : Human Semen and Fertility regulation in Men. (Ed) E.S.E. Hafez. Saint Luis, The C.V. Mosby Company, P.31, 1976.
2. Voglmayr, J. K. Metabolism of spermatozoa in the male tract. In: Regulatory Mechanisms of Male Reproductive Physiology, (Ed) Spilman, Lobl and Kirton. The Netherlands. Excerpta Medica Amsterdam, P.101, 1976.
3. Eliasson, R. Cholesterol in human semen. *Biochem. J.*, **98** : 242-243, 1966.
4. Doeg, K.A., L.L. Polomski and L. H. Doeg. Androgen control of mitochondrial and nuclear DNA synthesis in the male sex accessory tissue of castrate rats. *Endocrinology*, **90** : 1633-1637, 1972.
5. Umapathy, E., K. S. Manimekalai and P. Govindarajulu Hormonal influence on epididymal lipids. *Ind. J. Physiol. Pharmac.*, **23** : 121-126, 1979.
6. Folch, J., N. Lees and G. Sloane-Stanley. A similified method for isolation and purification of total lipids from animal tissues. *J. Biol. Chem.*, **226** : 497-502, 1957.
7. Hanel, H. K. and H. Dam. Determination of small amounts of cholesterol by Tschugaeff reaction with a note on the determination of lanosterol. *Acta Chem. Scand.*, **9** : 677-681, 1955.
8. Marinetti, G. V. Chromatographic separation, identification and analysis of phospholipid. *J. Lipid Res.*, **3** : 1-5, 1962.
9. Bieri, J. G. and E. L. Prival. Lipid composition of testis of various species. *Comp. Biochem. Physiol.*, **15** : 275-279, 1965.

10. Cavazos, L. F. and R. M. Melampy. Effect of differential testosterone propionate on rat accessory gland activity. *Iowa State Coll. J. Sci.*, **31** : 19-21, 1956.

11. Turner, P.C. and A. D. Johnson. Epididymal lipid of the rat with and without testicular contribution. *J. Reprod. Fertil.*, **27** : 249-252, 1971.

12. Danzo, B.J. and B.C. Eller. Androgen binding to cytosol prepared from epididymides of sexually mature castrated rabbits. Evidence for a cytoplasmic receptor. *Steroids*, **25** : 507-511, 1975.

13. Gambal, D. Anti-gonadotrophic hormones and lipogenesis in the testis and seminal vesicles of rat. *Arch. Biochem. Biophys*, **118** : 709-713, 1967.

14. Neumann, F. and H. Steinbeck. Handbook of Experimental Pharmacology, New Series Vol XXX/2, Germany, Springer-Verlag, 1974.

15. Lubicz-Nawrocki, C. M. Anomalous effects of progesterone on the maturation and survival of spermatozoa in the epididymis of golden hamster. *J. Endocrinol.* **58** : 199-203, 1973.

16. Tokuji, Kato, Yasutami Tanabe, Fumio One, Katsukino Kajio, Naotake Miyao, Toharu Hirakawa, Takayuki Chabata, Masaru Mizo Guchi, Hiromi Tanaka and Tomo Yuki Ishibe. Basic studies on the prostatic fluid of dog under various hormonal environments. *Endocrinol. Japan*, **12** : 173-180, 1965.

17. Mann, T. Male sex hormone and its role in reproduction. In : Recent Progress in Hormone Research, (Ed.) Gregory Pincus, Vol. XII, P. 353, 1956.

18. Deog K.A. Mitochondrial lipids and androgen. *Endocrinol.*, **82** : 535-540, 1968.

19. Singhal, R. L. and J.R.E. Valadares. Metabolic control mechanisms in mammalian systems. I. Hormonal regulation of phosphofructokinase in the rat prostate and seminal vesicles. *Biochem. J.*, **110** : 703-705, 1968

20. Rennie, P. and N. Bruchovsky. Studies on the relationship between androgen receptors and the transport of androgen in rat prostate. *J. Biol. Chem.*, **248** : 3288 3291, 1973.