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ENDOCRINE EFFECTS OF MASTURBATION IN MEN

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SUMMARY

The levels of pregnenolone, dehydroepiandrosterone (DHA), androstenedione, testosterone, dihydrotestosterone (DHT), oestrone, oestradiol, cortisol and luteinizing hormone (LH) were measured in the peripheral plasma of a group of young, apparently healthy males before and after masturbation. The same steroids were also determined in a control study, in which the psychological anticipation of masturbation was encouraged, but the physical act was not carried out. The plasma levels of all steroids were significantly increased after masturbation, whereas steroid levels remained unchanged in the control study. The most marked changes after masturbation were observed in pregnenolone and DHA levels. No alterations were observed in the plasma levels of LH.

Both before and after masturbation plasma levels of testosterone were significantly correlated to those of DHT and oestradiol, but not to those of the other steroids studied. On the other hand, cortisol levels were significantly correlated to those of pregnenolone, DHA, androstenedione and oestrone.

In the same subjects, the levels of pregnenolone, DHA, androstenedione, testosterone and DHT in seminal plasma were also estimated; they were all significantly correlated to the levels of the corresponding steroid in the systemic blood withdrawn both before and after masturbation.

As a practical consequence, the results indicate that whenever both blood and semen are analysed, blood sampling must precede semen collection.

INTRODUCTION

It is common practice in hospitals and fertility clinics for semen specimens to be provided by masturbation. This method of semen collection was used to provide material for a recent study involving the simultaneous determination of steroid levels in peripheral plasma (Purvis, Brenner, Landgren, Cekan & Diczfalusy, 1975*a*) and seminal plasma (Purvis, Landgren, Cekan & Diczfalusy, 1975*b*) of normospermic men. In studies of this type it is important that the interval between blood and semen collection be kept as short as possible. In the past the possible effects of masturbation on plasma steroid levels have been considered unimportant (e.g. Mauss, Börsch, Bormacher, Richter, Leyendecker & Nocke, 1975). However, there is a possibility that masturbation does alter blood plasma hormone levels. Investigation of this possibility has gained increasing inportance in view of the current interest in assessing the effects of various types of fertility-regulating agents and methods in men. In such studies blood samples and semen specimens must be obtained and analysed simultaneously.

In view of the above considerations, an experiment was designed which involved the assay of a number of steroids and luteinizing hormone (LH) in blood samples taken from a

group of young volunteers before and after providing a semen specimen by masturbation. The results obtained were then compared with those of a smaller control experiment, carried out on a number of the same subjects, who volunteered for this study. In this control study, the psychological preparation for masturbation was encouraged, but the physical act was not carried out.

Since semen was collected within a relatively short time of the two blood samplings, this study also provided an opportunity to assess the quantitative relationships between steroid levels in blood plasma and seminal plasma.

MATERIALS AND METHODS

Thirty-four volunteers, aged between 18 and 20 years, were recruited from a group of young conscripts engaged in their national service at Svea Livgarde in Stockholm. Each subject was asked to provide a semen specimen after a blood sample (10 ml) had been taken from the brachial vein by venepuncture. As soon as the semen specimen was obtained, a second blood sample was immediately taken and the time between the first and second bleeding was recorded. This period varied between 9 and 40 min.

All blood samples were taken between 08.30 and 11.30 h with heparinized syringes and immediately centrifuged at 1500 *g* for 15 min; the resulting plasma was quickly frozen in hexane–solid CO_2 mixture and stored at −20 °C until the day of assay. The semen specimens were allowed to liquefy at room temperature for 30 min, after which they were centrifuged at 1500 *g* for 10 min, when the resulting seminal plasma was divided into portions and rapidly frozen.

Two months after the completion of the first study, 11 individuals from the group volunteered to participate in a second study. They were led to believe that they would supply a semen specimen in exactly the same way as they had done on the previous occasion. However, after the first blood sample had been taken, they were asked merely to wait a stipulated time, without masturbating, and were then subjected to a second venepuncture. The time-interval was the same as that recorded for the individual during the first study. This second experiment will be subsequently referred to as 'sham masturbation'. Blood was collected between 08.30 and 11.00 h and treated as described above.

The radioimmunoassay procedures used for the assay of pregnenolone, dehydroepiandrosterone (DHA), androstenedione, testosterone, oestrone, oestradiol and LH have been described previously (Brenner, Guerrero, Cekan & Diczfalusy, 1973; Purvis *et al.* 1975*a*). Cortisol was measured by the radioimmunoassay method described by Ruder, Guy & Lipsett (1972) without previous chromatographic purification. The plasma samples in all hormone assays were processed in duplicate. Pregnenolone, DHA, androstenedione, testosterone, DHT and oestradiol were also assayed in the seminal plasma (also in duplicate), using the technique described previously by Purvis *et al.* (1975*b*).

In the statistical evaluation of the results, a lognormal distribution (Gaddum, 1945) of all individual hormone levels was assumed throughout the study.

RESULTS

The peripheral hormone levels measured in 34 subjects immediately before and after masturbation are presented in Table 1.

Masturbation was associated with a significant increase in the levels of all steroids studied, whereas LH levels in the circulation remained unchanged. From the quantitative point of view, the most marked changes after masturbation were observed in pregnenolone and DHA levels.

Statistical correlations were computed between all combinations of plasma steroids

Table 1. *Geometric means and 95 % confidence limits of peripheral hormone levels* before and after masturbation in 34 men*

Hormone	Masturbation		Difference† (*P*)
	Before	After	
Pregnenolone	1460 (1260–1690)	2020 (1680–2420)	< 0·001
Dehydroepiandrosterone	4230 (3490–5120)	6610 (5300–8240)	< 0·001
Androstenedione	1250 (972–1420)	1510 (1330–1730)	< 0·001
Testosterone	4230 (3560–5030)	4820 (4130–5630)	< 0·05
Dihydrotestosterone	492 (436–555)	540 (484–602)	< 0·001
Oestrone	31·0 (26·8–36·0)	33·8 (29·4–38·8)	< 0·05
Oestradiol	24·6 (21·9–27·6)	26·0 (23·1–29·2)	< 0·05
Cortisol	108 (96·0–121)	128 (113–144)	< 0·001
LH	5·43 (4·80–6·14)	5·62 (4·81–6·56)	Not significant

* All results are expressed in pg/ml, except for cortisol (ng/ml) and LH (mu./ml).
† Established by a two-sided paired *t* test.

Table 2. *Correlation of peripheral plasma steroids before and after masturbation*

	Cortisol	Pregneno-lone	Dehydro-epiandro-sterone	Andro-stenedione	Testo-sterone	Dihydro-testo-sterone	Oestrone
Oestradiol	NS	NS	*	*	**	*	**
	NS	NS	*	**	***	**	**
Oestrone	*	**	**	NS	NS	NS	
	***	**	**	NS	NS	NS	
Dihydrotesto-sterone	NS	NS	NS	*	***		
	NS	NS	NS	*	***		
Testosterone	NS	NS	NS	NS			
	NS	NS	NS	NS			
Androstenedione	*	*	***				
	**	**	***				
Dehydroepiandro-sterone	***	***					
	***	***					
Pregnenolone	***						
	***						

The significance of steroid correlations before masturbation is indicated in the first row, after masturbation in the second row; NS (not significant) stands for correlation coefficient from 0 to 0·338, * ($P < 0·05$) for r from 0·338 to 0·434, ** ($P < 0·01$) for r from 0·434 to 0·537, and *** ($P < 0·001$) for r greater than 0·537; $n = 34$ in all cases.

measured both before and after masturbation. The results are presented in Table 2. It can be seen from the data of Table 2 that both before and after masturbation plasma levels of testosterone were significantly correlated to those of DHT and oestradiol, but not to those of any other steroid studied. On the other hand, the levels of cortisol and pregnenolone were significantly correlated to each other and to the levels of DHA, androstenedione and oestrone.

When the post-masturbation steroid levels were plotted against the duration of masturbation (i.e. the interval between the first and second bleeding, a regression analysis showed that – with the exception of testosterone levels – the increase in post-masturbation plasma levels was independent of the duration of masturbation. In the case of testosterone, plasma levels appeared to be highest when the 'masturbation time' was approximately 20 min. With an increase in time, the levels seemed to decrease gradually. This is suggested by a negative correlation coefficient ($r = -0·375; P < 0·05$) and a negative slope ($b = -0·050 \pm 0·02186$; $P < 0·05$), both computed for all observations ($n = 34$).

The effects of 'sham masturbation' are presented in Table 3. The data indicate that in the 11 subjects studied, the anticipation of masturbation did not result in any significant effect on hormone levels in the peripheral blood.*

Table 3. *Geometric means and 95 % confidence limits of peripheral plasma hormone levels* in 11 men*

Hormone	Masturbation			'Sham masturbation'		
	Before	After	Difference‡	Before	After	Difference‡
Pregnenolone	1480 (1130–1940)	2240 (1640–3060)	$P < 0.001$	1680 (1300–2160)	1860 (1390–2470)	NS
Dehydroepiandrosterone	3940 (2750–5650)	7650 (5840–10000)	$P < 0.001$	5210 (3770–7170)	6140 (4360–8640)	NS
Androstenedione	1450 (1160–1810)	1810 (1430–2280)	$P < 0.001$	1320 (1110–1580)	1490 (1270–1740)	NS
Testosterone	4710 (3300–6720)	5850 (4390–7780)	NS†	7060 (5710–8690)	6900 (5670–8400)	NS
Dihydrotestosterone	586 (489–702)	651 (566–748)	NS†	650 (569–739)	647 (548–764)	NS
Oestrone	28·7 (25·6–32·2)	28·4 (17·3–46·7)	NS†	42·4 (38·0–47·2)	41·8 (36·9–47·1)	NS
Oestradiol	25·3 (20·5–31·4)	27·1 (21·8–33·7)	$P < 0.05$	25·0 (18·9–33·0)	24·5 (19·1–31·3)	NS
Cortisol	102 (82·6–126)	128 (104–156)	$P < 0.01$	104 (81·1–134)	120 (92·3–155)	NS
LH	5·34 (4·22–6·77)	4·82 (3·79–6·11)	NS	4·06 (3·02–5·44)	4·69 (3·53–6·24)	NS

* All results are expressed in pg/ml, except for cortisol (ng/ml) and LH (mu./ml).
† These differences were significant in the entire group of 34 men (Table 1).
‡ Established by a two-sided paired *t* test. NS = not significant.

Table 4. *Geometric means and 95 % confidence limits of steroidal levels in seminal plasma and their correlations with systemic blood levels obtained before and after masturbation*

Steroid	Seminal plasma (pg/ml)†	Correlation with: Pre-masturbation peripheral plasma	Correlation with: Post-masturbation peripheral plasma†‡
Pregnenolone	485 (414–566)	0·59**	0·46*
Dehydroepiandrosterone	1460 (1050–2020)	0·50*	0·40*
Androstenedione	244 (183–324)	0·49**	0·63***
Testosterone	97·1 (84·8–111)	0·50*	0·55**
Dihydrotestosterone	312 (236–410)	0·55**	0·54**

† $n = 25$, except for androstenedione and dihydrotestosterone, where $n = 28$.
‡ The significance of the correlation coefficients: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Finally, selected steroids were also analysed in the seminal plasma specimens and the levels correlated to those found in the peripheral blood both before and after masturbation. Because of the small volume of a few samples, these analyses could not be carried out on all specimens. The results are shown in Table 4. The data indicate that the seminal plasma levels

* For reasons which are incompletely understood, in this group of 11 men the levels of oestrone ($P < 0.001$), testosterone ($P < 0.01$), DHA ($P < 0.05$) and LH ($P < 0.05$) before 'sham masturbation' were higher than those found before masturbation.

of the steroids studied were significantly correlated to their levels in systemic blood, both before and after masturbation.

DISCUSSION

The levels of all plasma steroids studied were significantly increased after masturbation, although considerable differences existed in the extent to which the concentrations of different steroids responded to this act (Table 1). This was in marked contrast with the lack of increase in steroid levels in the circulation following 'sham masturbation' (Table 3). Since the only variable different in the two experiments was the physical act of masturbation, the observed differences must be attributed to this activity. In addition, the data suggest that any psychological reaction to venepuncture or the anticipation of masturbation will have little, if any, effect on steroid hormone levels.

Although masturbation increased the plasma levels of all steroids examined, the effect on steroids of predominantly adrenal origin was more marked than on those secreted mainly, if not entirely, by the testes. In men the adrenal cortex appears to be the major site of production not only for cortisol, but also for pregnenolone (McKenna & Brown, 1974), DHA (Rosenfeld, Hellman, Roffwarg, Weitzman, Fukushima & Gallagher, 1971) and androstenedione (Crafts, Llerena, Guevara, Lobotsky & Lloyd, 1968). The fact that the plasma levels of these steroids exhibited a pronounced increase within a short time of masturbation suggests that this activity is associated with a marked activation of adrenal function. Moreover, the finding that the levels of cortisol, pregnenolone, DHA and androstenedione were significantly correlated with each other and with cortisol levels both before and after masturbation (Table 2) strengthens the contention that they are primarily of adrenal origin. There is, however, some circumstantial evidence suggesting that some DHA (but probably no androstenedione) is secreted by the human testis (Lipsett, 1974; Jönsson, Olsson, Luttrop, Cekan, Purvis & Diczfalusy, 1975).

Whereas the levels of LH were not affected by masturbation, those of testosterone were significantly increased. This observation is at variance with that reported by Fox, Ismail, Love, Kirkham & Loraine (1972). The discrepancy may be accounted for by differences in the number of subjects studied and/or by differences in sampling time. Indeed, even in the present study, the increase in testosterone levels was not significant when only 11 subjects were studied (Table 3). Furthermore, the increased testosterone levels appeared to be negatively correlated to the 'masturbation time' between the two bleedings.

The fact that these changes in testosterone levels were unrelated to changes in LH levels suggests that they were not induced via the pituitary-gonadal system. Nor is there any suggestion that the levels of testosterone were related to fluctuations in those of adrenal steroids, since the levels of testosterone were uncorrelated to those of cortisol, pregnenolone, DHA and androstenedione. It is possible that the limited increase in testosterone levels, or for that matter all of the observed alterations in adrenal and gonadal hormone levels, simply reflect a transitory cardiovascular change due to sexual arousal, which flushed out the hormones from the capillary bed, a mechanism suggested by Lincoln (1974) to explain the rise in testosterone levels in the circulation during intercourse. Obviously, single hormone determinations convey only limited information about the response of an endocrine gland, especially when the hormones under consideration exhibit episodic fluctuations, such as LH (Nankin & Troen, 1972; Boyar, Perlow, Hellman, Kapen & Weitzman, 1972), testosterone (Vermeulen, Verdonck & Comhaire, 1974) and cortisol (Rosenfeld *et al.* 1971).

Future studies employing a combination of simultaneous steroid assays with multiple sampling techniques might result in a better understanding of the mechanisms underlying the demonstrated alterations in steroid levels. On the other hand, the present data indicate that masturbation can have ramifying effects throughout much of the endocrine system,

and future hospital practice and clinical research must take this into account, when both semen and blood samples are required from the same subjects.

The demonstrated correlation of the steroid levels in systemic blood and seminal plasma seems to suggest that in the majority of cases there is an equilibrium between these two compartments. These correlations require further studies under a variety of experimental conditions. The possibility of a ready passage of steroids from the peripheral circulation into the fluids of the male reproductive tract would be of major importance in the development of fertility-regulating agents with a peripheral mechanism of action.

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