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Durational effects of hemispaying on ovarian hypertrophy and estrous cycle in albino rats

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Abstract. Ovarian hypertrophy is studied by hemispaying the rats for 7, 15, 20, 25 and 30 days. The compensatory hypertrophy of the ovary is calculated in relation to their respective sham operated controls. The maximum hypertrophy is observed 20 days after hemispaying, as indicated by ovarian weight and its histological observations. Thereafter the hypertrophic response though significant, decreases gradually, indicating that once the circulating estrogen secreted by the hypertrophied ovary comes to preoperative level, the pituitary gonadotrophin level also falls down. The hemispaying has no significant effect either on the duration or number of estrous cycle.

Keywords. Ovarian compensatory hypertrophy; hemispaying; estrous cycle.

1. Introduction

Unilateral ovariectomy or hemispaying causes compensatory follicular proliferation, ovulation and hypertrophy in rats, mice and hamsters (Arai 1920 ; Mandl and Zuckerman 1951; Greenwald 1961 ; Pepler 1975). This may be due to the unchanged availability of pituitary gonadotrophins (FSH and LH) to the remaining single ovary and/or increase in the pituitary release of gonadotrophins due to decrease in the circulating estrogen after semiovariectomy (Edgren *et al* 1965 ; Welchen 1970, 1972; Howland *et al* 1974). The compensatory response of the ovary may continue till the ovary gets the increased amount of pituitary gonadotrophins and once the gonadotrophins level falls down to normal, due to increase in the steroid output by the hypertrophied ovary, this compensatory hypertrophy may also decrease. Therefore, the present investigation is to study the duration required to obtain the optimum hypertrophy in albino rats.

2. Material and methods

Nulliparous, female albino rats of Holtzman strain, with regular established estrous cycle, weighing 130-150 g, 70-80 days old were hemispayed. The right

ovary was exposed by dorsolateral route, major blood vessels were ligated and after split opening the bursa, the ovary was carefully removed. Sham operation was performed by just exposing the right ovary. All operations were carried at estrous, under mild ether anaesthesia.

The experimental rats were maintained in individual cages, with Hindustan Lever rat feed, at water *ad libitum*, at a room temperature of 27 ± 1° C and 12 hr light/darkness.

The estrous cycle of all the experimental rats were studied everyday morning by vaginal smear observations. The rats were autopsied after 7, 15, 20, 25 and 30 days. Ovaries were dissected out free from adherent tissue, weighed, fixed in Bouin's fluid, sectioned and stained with heamatoxylin eosin.

3. Results

3.1. *Ovarian hypertrophy*

The present investigation is to study the durational effects of hemispaying on ovarian hypertrophy. In sham operated controls, there is no appreciable change in the ovarian weight from day 7 to 30. In hemispayed rats compensatory hypertrophy is observable as early as 7 days after the operation, wherein per cent hypertrophy is 25·56 ($P<0·1$). This hypertrophic response gradually increases by 15 and 20 days wherein the respective per cent hypertrophy is 50·41 ($P<0·01$) and 96·40 ($P<0·001$) in relation to respective sham operated controls. Thereafter though the ovarian hypertrophy is significant as evidenced by the hemispaying for 25 and 30 days wherein 65.54% ($P<0.001$) and 64.74% ($P<0·001$) hypertrophy, is seen respectively, it is slightly less compared to that of 20 days (table 1).

Table 1. Durational effect of hemispaying on ovarian hypertrophy in albino rats.

Duration (days)	Ovary wt. mg/100 g Body wt. M ± S.E.		% hypertrophy
	Sham operated	Hemispayed	
7	17·18±0·95	21·57±1·91*	25·56
15	18·46±1·85	27·77±0·98**	50·43
20	15·40±0·30	30·24±1·94***	96·40
25	16·92±0·94	28·06±1·99***	65·54
30	17·72±0·26	29·31±1·14***	64·74

% hypertrophy is calculated in relation to respective sham operated controls.

M ± S.E. = Mean ± standard error.

*$P = 0·1$; **$P = 0·01$; ***$P = 0·001$.

3.2. *Ovarian weight*

The ovarian weight in the hemispayed rats also goes on increasing from day 7 to 20, and by day 20 the ovarian weight is almost doubled in hemispayed rats (30·24 ± 1·94 mg) in relation to their sham operated controls (15·40 ± 0·30 mg) with 96·40% compensatory hypertrophy. Then onwards gradually the ovarian weight falls down along with a decrease in the ovarian compensatory hypertrophy.

3.3. *Ovarian histology*

Histological observations indicate that the initiation of the ovarian hypertrophy after hemispaying begins as early as 7 days, wherein the ovary shows large corpora lutea and graafian follicles. Significant ovarian hypertrophy is seen by 15 days, but it is maximum by 20 days wherein the ovaries are large with well developed corpora lutea and graafian follicles, indicating the increased follicular proliferation and ovulation. Similar observations in the ovarian histology is made after 25 days and 30 days of hemispaying, though the ovarian hypertrophic response is slightly reduced.

3.4. *Estrous cycle*

The cyclical changes observed in the study of estrous cycle gives a fair index of the ovarian activities (table 2). In the present experiment hemispaying has no significant effect on estrous cycle either in the duration of diestrus or on the number of estrous cycles. In sham operated rats the duration of diestrus ranges from 2·8 to 3·0 days whereas it is 2·5 to 3·1 days in hemispayed rats. The number of estrous cycles goes on increasing gradually with the increase in the

Table 2. Durational effect of hemispaying on estrous cycle in rats.

Duration (days)	duration of diestrus M ± S.E.		Number of cycles M ± S.E.	
	Sham operated	Hemispayed	Sham operated	Hemispayed
7 (5)	3·0±0·0	3·1±0·2	1·0±0·0	1·2±0·2
15 (5)	2·9±0·5	2·0±0·3	2·8±0·2	2·8±0·2
20 (5)	2·8±0·3	2·5±0·1	3·0±0·2	4·0±0·0
25 (5)	3·0±0·2	3·1±0·3	4·4±0·2	4·6±0·1
30 (5)	2·7±0·2	2·9±0·2	6·0±0·3	5·8±0·2

M ± S.E. = Mean ± standard error.
Number in parenthesis denotes the number of rats.

duration of the experiment in both sham operated and hemispayed rats. The number of estrous cycles ranges from 1·0 to 6·0 from day 7 to 30. It is evident from the above results that these rats are regular 5 days cyclers with 3 days of diestrus. The hemispayed rats though having single ovary can maintain the hormonal balance which is essential for the vaginal cornification.

4. Discussion

Ovarian compensatory hypertrophy and ovulation after hemispaying is observed by several investigators in rats, mice, hamsters and guinea pigs (Arai 1920 ; Greenwald 1961 ; Hermerck and Greenwald 1964 ; Peppler 1975). The compensatory hypertrophy is evident even in the neonatal rats, pregnant and pseudopregnant rats, but not so apparent in aged rats, since there is a decline in the pituitary output of FSH and LH during that period (Labhsetwar 1967, 1969 ; Chatterjee and Greenwald 1971; Peppler 1971). In spite of several investigations the mechanism of ovarian compensatory hypertrophy is still debatable. It is alluded to relative increase in the availability of serum gonadotrophins to the remaining single ovary after hemispaying, since no increase in the pituitary gonadotrophins is observable after hemispaying (McLaren 1963, 1966 ; Edgren *et al* 1965). However, this contention is questioned as there is an increase in the gonadotrophin output, due to decrease in the circulating estrogen after hemispaying which is responsible for the ovarian compensatory hypertrophy (Grady and Greenwald 1968 ; Benson *et al* 1969 ; Walshen 1970, 1972 ; Howland and Skinner 1973). But according to Greenwald (1968) and Peppler (1972) the mechanism of ovarian hypertrophy involves not only an increase in the output of pituitary gonadotrophins, but also the time of exposure to the available gonadotrophins.

In this paper the ovarian compensatory hypertrophy in relation to sham operated controls is enhanced with the duration of hemispaying. Therefore the ovarian compensatory hypertrophy obtained after 7 days is not significant ($P<0·1$), significant after 15 days ($P<0·01$) and highly significant thereafter ($P<0·001$). These results agree with those of Greenwald (1968) and Peppler (1972), wherein the significant compensatory hypertrophy is obtained with an increase in the time of exposure of the ovary to the constant gonadotrophic levels. The maximum ovarian hypertrophy is observed by 20 days after hemispaying. These results appear to be in agreement with those of Benson *et al* (1969), wherein an increase in the initial surge of serum FSH is seen on day 4, comes to preoperative levels by day 20 to 24. Therefore ovarian hypertrophy increases up to day 20 and once the circulating estrogens come to preoperative level there will be no increase in the gonadotrophin output, hence the hypertrophic response of the ovary also decreases after 20 days.

The study of estrous cycle indirectly indicates the gonadotrophins output from the pituitary, preceded by the ovarian estrogen secretion. In the present investigation hemispaying has no effect on the duration of estrous cycle wherein the diestrus extends from 3–4 days both in sham operated and hemispayed rats, which is in full agreement with the opinion held by Greenwald (1960) and Peppler and Greenwald (1970). The number of estrous cycles increases from 1 to 6 as the

duration of the experiment increases from day 7 to 30, in both sham operated and hemispayed rats. This indicates that the steroid hormone production from the remaining single ovary in hemispayed rats is sufficient for the vaginal cornification even before the significant ovarian hypertrophy takes place.

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