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片側去勢 및 片側潛伏精巢가 흰쥐의 血中 FSH, LH, Testosterone 水準 및 精巢發達에 미치는 影響

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Effects of Unilateral Castration and Cryptorchidism on Serum FSH, LH and Testosterone Levels and Testicular Development in Immature Rats

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I. 要 約

本實驗은 未成熟 수흰쥐에서 片側去勢와 片側潛伏精巢가 血中 FSH, LH 및 testosterone 水準, 그리고 體重, 精巢發達과 精巢組織의 變化에 미치는 影響을 觀察하기 위하여 실시하였으며 未成熟 수흰쥐 144마리를 對照區, 片側去勢區 및 片側潛伏精巢區로 나누어 30日齡에서 外科的으로 片側去勢 및 片側潛伏精巢處理한 후 5日 및 10日간격으로 體重을 測定한후 屠殺採血하여 radioimmunoassay에 의하여 血中 FSH, LH 및 testosterone水準을 測定하였고 精巢를 摘出하여 重量을 測定한 후 精巢組織을 光學 및 電子顯微鏡으로 觀察하였던바 다음과 같은 結果를 얻었다.

血中 FSH水準은 片側去勢區와 片側潛伏精巢區는 處理後 5日에 對照區보다 낮은 水準을 나타냈으나 處理後 10日에는 片側潛伏精巢區는 對照區에 비해 큰 差가 없었으나 片側去勢區는 조금 높은편이였다. 그리고 處理後 50日에는 對照區, 片側去處區 및 片側潛伏精巢區사이에는 5%水準의 有意差를 나타냈다.

血中LH水準은 處理後 5日에 片側去處區와 片側潛伏精巢區는 增加하여 有意性을 나타냈다($P<0.01$).

血中testosterone水準은 對照區가 持續的인 增加를 하였고 片側去處區는 處理後 20日부터 50日까지 增加하여 對照區보다 높은 水準을 나타냈고 片側潛伏精巢區는 對照區와 비슷한 水準을 나타냈고 各處理區 사이에는 有意的 差가 없었다. 體重은 各處理區 사이에 別差없이 같은 增加를 했다.

精巢重量은 對照區, 片側去勢區 및 片側潛伏精巢區의 陰囊精巢는 繼續 다같이 增加했으나 片側潛伏精巢區의 陰囊精巢는 他區들에 비하여 무거웠으며 5%水準의 有意性을 나타냈고 片側潛伏精巢區의 腹腔精巢는 조금 增加는 하였으나 陰囊精巢의 1/2에 불과했다.

細精管上皮細胞層의 두께는 對照區, 片側去勢區 및 片側潛伏精巢區의 陰囊精巢는 繼續增加하였으나 片側潛伏精巢區의 腹腔精巢는 他區에 비해 減少하여 處理後 20日부터는 크게 有意差를 나타냈다($P<0.01$).

細精管의 直徑은 對照區, 片側去勢區 및 片側潛伏精巢區의 陰囊精巢는 繼續增加한 반면 片側潛伏精巢區의 腹腔精巢는 處理後 20日부터는 他區에 비하여 減少하였으며 1%水準의 有意性을 나타냈다.

精巢組織의 顯微鏡的 所見은 對照區, 片側去勢區 및 片側潛伏精巢區의 陰囊精巢에서는 時間이 經過

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할수록 精子發生 過程이 활발히 進行됨을 觀察할 수 있었으나 片側潛伏精巢區의 腹腔精巢는 處理後 5日부터 현저한 退行變化를 일으켜 精子生成機能이 완전히 상실됨을 觀察할 수 있었다.

電子顯微鏡的 檢索에서도 對照區, 片側去勢區및 片側潛伏精巢區의 陰囊精巢는 正常的인 精子形成過程을 觀察할 수 있었으나 片側潛伏精巢區의 腹腔精巢에서는 細精管周圍組織의 固有膜이 正常的으로 境界를 이루지 못했고 平滑筋纖維가 肥厚하여 細精管周圍組織이 두꺼워졌고 leidig細胞와 sertoli 細胞에는 濃縮된 脂肪滴이 많이 나타나 退行狀態를 나타냈다.

Introduction

Eik-Nes (1966) reported that the mechanism of spermatogenesis is controlled by FSH and LH and maintained normally in scrotum temperature which is 3-5°C lower than body temperature. But Ojeda and Ramirez (1972) have described that the abdominal testis was shrinked severely and lost its normal function in congenital cryptorchidism or surgically induced cryptorchidism.

Ramirez and Sawyer (1974) reported that the compensatory hypertorphy occured in the remaining testis of unilateral castration and the scrotal testis of unilateral cryptorchidism.

Cunninham et al. (1978) reported that the serum FSH level increased after unilateral castration. Frankel and Wright (1982) reported that the serum LH level was unchanged greatly after unilateral castration. Gomes and Jain (1976) reported that the serum testosterone level increased temporarily but not varied after unilateral castration. On the other hand, Kormano et al. (1964) reported that the serum FSH level in unilateral cryptorchidism rat was unchanged in contrast with the control and Risbridger et al. (1981) reported that the serum LH level was unchanged till 2 weeks after operation and after then increased to 77%. Kim (1984) reported that the serum testosterone level was somewhat lower than that of control group but there wasn't significant different. There were many different reports on hormone levels among different investigators when the immature rats were castrated unilaterally or induced cryptorchidism unilaterally.

Liang and Liang (1970) and Cunningham et al. (1978) described that there were no true compensatory hypertrophy in the remaining testis of unilateral castration and scrotal testis of unilateral testis of unilateral cryptorchidism in rat but they grew faster than that of control.

Kormano et al.(1964), Damber et al.(1976), Cunningham et al.(1978) and Karpe et al.(1981) reported that the testis weight, germinal epithelia height and seminiferous tubules diameter developed continuously and similarily in the control, the remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism increased, however, in the abdominal testis of the unilateral cryptorchidism, they were much smaller than those of other groups.

In observation of the histological changes in the seminiferous epithelium of control, remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism differentiated and developed fully (Cunningham et al., 1978). However, the abdominal testis of unilateral crytorchidism degenerated severely and only the germ cells in early stage and Sertoli cells were found in the seminiferous tubules. (Damber et al., 1976, Gomes and Jain, 1976 and Karpe et al., 1981).

By electron microscopic observation, Nagano (1963) and Leason and Leeson (1970) found that the abdominal testis of unilateral cryptorchidism was thickened in boundary tissue, increased lipid droplet in the Sertoli cell, disarranged axial filament complex and increased lipid inclusions in the Sertoli cell.

Materials and Methods

One hundred and forty four Sprague Dawley strain male rats were devided into three groups of control, unilateral castration and unilateral cryptorchidism which was subdivided into two groups of scrotal testis and abdominal testis. Forty eight rats were allotted to each group and they were subjected to unilateral castration and unilateral cryptorchidism by surgical operation at 30 days of age. Six rats from each group were taken 0, 5, 10, 20, 30, 40, 50, and 60 days after operation, and anaesthetized and exsanguinated by cardiac puncture.

Serum FSH, LH and testosterone levels were measured using radioimmunoassay method. The testes removed from the rats were trimmed and weighed and then examined the histological changes by the light and electron microscope.

Results

Serum FSH level in control was increased until 20 days after operation and decreased thereafter. The levels of the unilateral castration at 10, 50 and 60 days after operation were higher than the control. Also the levels of unilateral cryptochidism at 10 and 20 days after operation were increased, however their levels were decreased at 30, 40, 50 and 60 days after operation. The serum FSH levels of castration and cryptochidism at 60 days after operation were 33 and 47% higher than that of control respectively.

Table 1. Effect of unilateral castration and cryptorchidism on the levels of serum FSH

(mIU/ml)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism	Duncan's MR test
0 (30)	0.89±0.06	0.80±0.14	0.73±0.08	C Cr U
5 (35)	1.26±0.35	0.34±0.04	0.35±0.07	C Cr U
10 (40)	1.46±0.10	2.04±0.48	1.36±0.54	U C Cr
20 (50)	1.77±0.14	0.38±0.12	1.18±0.30	C Cr U
30 (60)	0.87±0.18	0.40±0.05	0.65±0.05	C Cr U
40 (70)	0.53±0.07	0.50±0.06	0.44±0.04	C U Cr
50 (80)	0.30±0.02	0.51±0.05	0.46±0.02	*U Cr C
60 (90)	0.36±0.02	0.48±0.08	0.53±0.07	Cr U C

※ : $P<0.05$

Table 2 shows that the effect of unilateral castration and cryptorchidism on the levels of serum LH. Serum LH level in control peaked at 10 days after operation. In the unilaterally castrated group the level was higher than that in control group through all the experimental period. Moreover, the level was significantly higher at 5 days after operation, and the level of unilateral cryptorchidism increased temporarily at 5 days after operation, and after then it was slightly lower or higher than that of control but there was not significant difference.

Effect of unilateral castration and cryptorchidism on the levels of serum testosterone were shown in table 3.

Serum testosterone level in control increased continuously from beginning to the end of the experiment and in the unilateral castration it was higher than that in control at 5 days, 10 days, 40 days and 50 days after operation but it was

Table 2. Effect of unilatral castration and cryptorchidism on the levels of serum LH

(mIU/ml)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism	Duncan's MR test
0 (30)	1.04±0.07	1.42±0.18	1.05±0.06	U Cr C
5 (35)	0.99±0.04	1.56±0.11	2.67±0.47	**Cr U C
10 (40)	1.92±0.51	2.90±1.16	0.75±0.23	U C Cr
20 (50)	1.13±0.08	0.72±0.08	0.74±0.05	C Cr U
30 (60)	1.36±0.10	1.89±1.03	2.20±0.05	Cr U C
40 (70)	0.98±0.27	1.86±0.21	1.07±0.46	U C Cr
50 (80)	0.35±0.08	1.87±0.70	0.76±0.10	U Cr C
60 (90)	1.26±0.17	1.94±0.63	1.06±0.06	Cr C U

** : $P<0.01$

lower at 20 days, 30 days and 60 days after operation.

The testosterone level in unilateral cryptorchidism was slightly higher than that in control at 40 days after operation but it was lower at 50 days and 60 days after operation.

Table 3. Effect of unilateral castration and cryptorchidism on the levels of serum testosterone

(mg/ml)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism	Duncan's MR test
0 (30)	0.17±0.03	0.29±0.02	0.18±0.06	C Cr U
5 (35)	0.16±0.01	0.35±0.03	0.68±0.26	Cr U C
10 (40)	0.22±0.01	0.32±0.08	0.37±0.07	Cr U C
20 (50)	0.74±0.12	0.39±0.07	1.64±0.63	Cr C U
30 (60)	1.10±0.32	0.69±0.13	1.11±0.59	Cr C U
40 (70)	1.18±0.39	1.74±0.32	1.28±0.23	U Cr C
50 (80)	1.58±0.08	1.90±0.32	1.10±0.06	U C Cr
60 (90)	1.62±0.12	1.27±0.01	1.43±0.03	C Cr U

Table 4, shows that the effect of unilateral castration and cryptorchidism on the body weight.

The body weight in all the experimental group were not varied and there were not significantly different during all the experimental periods.

The effect of unilateral castration and cryptorchidism on the testis weight was showed in table 5. The weight of testis in control, remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism increased continuously, especially the reamining testis of unilateral castration was higher than those of other groups but there was not significant difference, therefore, it was thought that this was not true compensatory hypertrophy. On the other hand, the weight of the abdominal testis of unilateral cryptorchidism increased slightly until 30 days after operation but was one half as heavy

Table 4. Effect of unilateral castration and cryptorchidism on the body weight

(g)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism	Duncan's MR test
0 (30)	58.5± 2.8	61.5± 1.4	55.5± 2.4	U C Cr
5 (35)	88.8± 3.2	86.0± 3.8	87.5± 3.1	C Cr U
10 (40)	106.5± 4.5	102.5± 1.4	102.3± 5.4	C U Cr
20 (50)	130.3± 9.3	137.3±12.4	140.8± 4.4	Cr U C
30 (60)	178.8±18.1	197.0± 7.8	220.8± 2.7	Cr U C
40 (70)	207.3±18.7	216.3±10.8	230.0± 9.8	Cr U C
50 (80)	271.3± 9.3	266.5±11.4	276.0±13.9	Cr C U
60 (90)	285.5±10.3	293.3±11.2	293.5± 4.7	Cr U C

Table 5. Effect of unilateral castration and cryptorchidism on the testis weight

(g)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism Scrotal testis	Abdominal testis	Duncan's MR test
0 (30)	0.26±0.02	0.26±0.02	0.28±0.02	0.29±0.01	A S U C
5 (35)	0.45±0.02	0.54±0.03	0.55±0.02	0.53±0.10	S U A C
10 (40)	0.53±0.06	0.60±0.05	0.69±0.01	0.46±0.02	*S U C A
20 (50)	0.88±0.09	0.95±0.05	0.98±0.00	0.72±0.04	S U C A
30 (60)	1.16±0.06	1.29±0.06	1.26±0.08	0.76±0.04	**U S C A
40 (70)	1.21±0.04	1.49±0.08	1.45±0.05	0.73±0.05	**U S C A
50 (80)	1.45±0.04	1.53±0.03	1.35±0.05	0.74±0.04	**U C S A
60 (90)	1.50±0.03	1.54±0.08	1.46±0.04	0.76±0.05	**U C S A

*: $P<0.05$ **: $P<0.01$

as scrotal testis.

The histological changes in seminiferous epithelia of control, the remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism differentiated fully as time elapses and normal function of spermatogenesis were observed. On the other hand, the seminiferous epithelium in the abdominal testis of unilateral cryptorchidism degenerated severely and lost its mechanisms of spermatogenesis from 5 days after operation.

Electron microscopic observation showed that the seminiferous tubules in control, remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism were mormal in functions of spermatogenesis. However, the abdominal testis of unilateral cryptorchidism degenerated and tunica propria of the boundary tissue was disarranged and thickened by increased smoth muscle fiber in the boundary tissue.

And many lipid droplets appeared in the Leydig cells and the Sertoli cells.

Table 6. Effect of unilateral castration and cryptorchidism on the germinal epithelium height

(μ m)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism		Duncan's MR test P. <0.05
			Scrotal testis	Abdominal testis	
0 (30)	72.0±0.1	73.0±0.1	71.0±0.1	71.0±0.1	U C S A
5 (35)	76.0±0.1	73.5±0.2	75.5±0.3	71.3±0.4	C S U A
10 (40)	73.5±0.1	74.6±0.3	75.5±0.3	70.0±0.1	S U C A
20 (50)	78.3±0.2	80.0±0.1	85.0±0.2	68.0±0.0	**S U C A
30 (60)	89.0±0.2	87.7±0.3	91.0±0.2	77.5±0.3	*S C U A
40 (70)	92.0±0.2	92.0±0.1	93.0±0.1	76.7±0.4	**S U C A
50 (80)	93.5±0.2	98.5±0.3	94.0±0.0	74.0±0.1	**U S C A
60 (90)	96.5±0.1	98.0±0.2	94.7±0.1	63.6±0.1	**U C S A

*: P <0.05 **: P <0.01

Table 7. Effect of unilarteral castration and cryptorchidism on the seminiferous tubule diameter

(μ m)

Days after operation (age)	Control	Unilateral castration	Unilateral cryptorchidism		Duncan's MR test
			Scrotal testis	Abdominal testis	
0 (30)	152.5±0.3	159.0±0.2	173.5±0.7	161.0±0.1	S A U C
5 (35)	200.5±0.4	210.0±0.2	211.1±1.2	196.2±0.6	S U C A
10 (40)	215.0±0.3	210.2±0.2	219.0±0.6	189.0±0.3	S C U A
20 (50)	240.0±0.1	263.0±0.2	251.0±0.2	172.2±0.6	**U S C A
30 (60)	261.4±0.4	270.5±0.6	263.0±0.3	194.0±0.2	*U S C A
40 (70)	273.7±0.8	256.0±0.2	269.6±0.2	204.5±1.6	*C S U A
50 (80)	276.0±0.6	279.2±0.3	271.0±0.3	214.0±0.5	**U C S A
60 (90)	285.0±1.4	286.5±0.7	274.0±0.1	195.6±1.1	**U C S A

*: P<0.05 **: P<0.01

Discussion

Serum FSH level in control increased till 20 days after operation and decreased again, which disagreed with Lee et al. (1975) and somewhat agreed with Swerdloff et al. (1971). Serum FSH level in unilateral cryptorchidism at 10, 50 and 60 days after operation was higher than in control and this result was similar to Gomes and VanDemark (1974) and Cunningham et al. (1978).

Serum FSH level in unilateral cryptorchidism at 10 and 20 days after operation increased temporarily and decreased again and at 50 and 60 days after operation 53% and 47% increased, respectively. This result somewhat agreed with Gomes and VanDemark (1974) and Cunningham et al. (1978) but disagreed with Schenck and

Neumann (1977) and Risbridger et al. (1981).

Serum LH level in control peaked at 10 days after operation, this result coincided higher than that in control through all the experimental period, moreover it was significantly higher at 5 days after operation ($P<0.01$). This result somewhat agreed with Ojeda and Ramirez (1972) but disagreed with Frankel and Wright (1982).

Serum LH level in unilateral cryptorchidism increased temporarily at 5 days after operation and after then slightly lower or higher than that in control but there was not significant difference and agreed with Kormano et al. (1964) and Kim (1984) but disagreed with Risbridger et al. (1981).

Serum testosterone level in control increased continuously from beginning to the end of the experiment and agreed with Kim (1984).

Serum testosterone level in unilateral castration was higher than in control at 5, 10, 40 and 50 days after operation but was lower at 20, 30 and 60 days after operation and they were agreed with Gomes and Jain (1976) and Cunningham et al. (1978) but disagreed with Mock and Frankel (1982).

Serum testosterone level in unilateral cryptorchidism was slightly higher than that in control at 40 days after operation but was lower at 50 and 60 days after operation. And it was agreed with Schenck and Neumann (1977) and Kim (1984) but disagreed with Kormano et al. (1964), Eik-Nes (1966) and Gomes and Jain (1976).

Testis weight in control, remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism increased continuously, especially, the remaining testis of unilateral castration was higher than those of other groups but there was not significant difference, therefore it was not compensatory hypertrophy. This result agreed with Gomes and Jain (1976) and Frankel and Wright (1982).

The abdominal testis of unilateral cryptorchidism increased slightly till 30 days after operation but was one half as heavy as scrotal testis, which agreed with Gomes and Jain (1976) and Karpe et al. (1982) but disagreed with Damber et al. (1976).

Seminiferous tubule diameter and germinal epithelium height of the control, the remaining testis of unilateral castration and the scrotal testis of unilateral cryptorchidism increased continuously together but those in the abdominal testis of unilateral cryptorchidism didn't increased so much as other groups and was different significantly ($P<0.01$). These results agreed with Eik-Nes (1966), Damber et al. (1976) and Gomes and Jain (1976).

In observations using microscope, the histological changes in the seminiferous epithelia of control, the remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism differentiated fully as time elapses and normal development of spermatogenesis were observed. On the other hand, the seminiferous epithelium in the abdominal testis of unilateral cryptorchidism degenerated severely and lost its mechanisms of spermatogenesis from 5 days after operation.

These results agreed with Gomes and Jain (1976), Karpe et al. (1981) and Kormano et al. (1964).

Electron microscopic observation showed that the seminiferous tubules in control, remaining testis of unilateral castration and scrotal testis of unilateral cryptorchidism were normal in functions of spermatogenesis. However, the abdominal testis of unilateral cryptorchidism degenerated and tunica propria of the boundary tissue was disarranged. The boundary tissue of

the seminiferous tubule in the abdominal testis of unilateral cryptorchidism was thickened by increased smooth muscle fiber of the boundary tissue. And many lipid droplets appeared in Leydig sells and Sertoli cells. These results agreed with Leeson and Leeson (1970).

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