PART II

CHAPTER IV

STRUCTURAL CHANGES IN THE TESTIS

IN VASECTOMID ALBINO RATS
A series of twenty-two healthy albino rats were utilized for experimental purpose. Out of them four albino rats were maintained purely as control animals, and the rest were subjected to experimental operations as follows:

1. **BILATERAL VASECTOMIES** were performed on (1) specimens 2\textsuperscript{V} and 10\textsuperscript{V} against which specimens 2\textsuperscript{VC} and 10\textsuperscript{VC} respectively were maintained as control. All the four animals of the series were of the same litter. (ii) specimens 11\textsuperscript{V} and 12\textsuperscript{V} against which specimens 11\textsuperscript{VC} and 12\textsuperscript{VC} respectively were maintained as control. All the four animals of this series were approximately of the same weight, but not of the same litter.

2. **UNILATERAL VASECTOMIES** were performed on (1) specimens 3\textsuperscript{V} and 18\textsuperscript{V}, all vasectomised on the right sides only and the left sides kept untouched or undisturbed. (ii) specimen 15\textsuperscript{V} was vasectomised on the left side and the right side left undisturbed. The testes of the undisturbed sides were utilized as control.

3. **UNILATERAL VASECTOMIES** were performed with 'Mock' operations on the contralateral sides on (1) specimens 4\textsuperscript{V} to 9\textsuperscript{V}, 13\textsuperscript{V}, 14\textsuperscript{V} and 16\textsuperscript{V}, all vasectomised on the left sides with 'Mock' operations performed on the contralateral sides i.e., just exposing the vas and then closing the wound.
(11) specimen 17\textsuperscript{V} was vasectomised on the right side with a 'Mock' operation on the contralateral side. The testes of the sides on which 'Mock' operations were performed served as a more scientific control.

The seriality in the specimens have been re-arranged in an ascending order in accordance with the number of days elapsed following experimental operations.

The observations on the testes of experimental animals in respect of gross anatomy and histology have been made. Micrometric measurements of different elements composing the gland are also recorded in selected cases.

In Table 1, body weight and absolute weight of testis with its relative weight in proportion to body weight in 'Control' testes, in Table 2, the same in 'Vasectomised' testes, in Table 3, dimensions of the testis and specific gravity of testis tissue in 'Control' testes, in Table 4, the same in 'Vasectomised' testes, in Table 5, absolute weight of testis, and absolute weight of epididymis with its relative weight in proportion to testis weight in 'Control' testes, in Table 6, the same in 'Vasectomised' testes, in Table 7, average body weight, average testis weight with average relative weight of testis in both 'Control' and 'Vasectomised' testes, in Table 8, average dimensions of testis and average specific gravity of testis tissue in both 'Control' and
'Vasectomised' testes, in Table 9, average testis weight and average weight of epididymis with its relative weight in proportion to testis weight in both 'Control' and 'Vasectomised' testes, and in Table 10, the average diameter of seminiferous tubules, average thickness of tunica albuginea as well as of basement membrane et tunica propria and average width of intertubular space in both 'Control' and 'Vasectomised' testes, have been detailed.

The study of relevant references reveals that workers in the past often used the terms "normal, abnormal, degeneration or atrophy" in their studies on vasectomised testis without giving any indication about the criterion by which the conditions were assessed. In the present study these terms have also been used, especially in noting the histologic observations on the vasectomised testis. In fact, as in general, the term "normal" denotes a range and not a fixed point. Hence, when the changes in the testis are found to be insignificant and confined within the limit of a reasonable range, the term "normal" has been used, but when these changes are found to be extensive and have surpassed the limit of the range, the terms "abnormal, degeneration or atrophy", have been used. However, assessment of the conditions or changes in the histologic picture of the testes in experimental albino rats were based on the following different forms of degeneration :-
1. Hydropic degeneration or serous degeneration, - the epithelial cells (spermatogenic cells) become distended with fluid, sometimes to such an extent that they burst.

2. Cloudy swelling or albuminous degeneration, - due to disturbance of cellular metabolism: the cells become swollen and unduly granular and as the condition advances the cells may break down and granular material which is albuminous in character, is discharged into the lumina of the tubules. Post-mortem autolysis produces identical picture.

3. Necrosis, a local death of the cell or necrobiosis, a gradual degeneration and death of the cell, - recognised by changes in the cell body and in the nucleus: (a) The cellular changes are swelling of the cytoplasm which becomes homogeneous and loses its normal reticulated appearance with loss of the normal sharp contour and obliteration of the cell boundaries. (b) The nuclear changes that are more striking and important for determining the presence of necrosis are of 3 different types: (i) chromatolysis or karyolysis, - chromatin appears to be dissolved and the nucleus gradually fades from sight. This is the commonest change. (ii) karyorrhexis, - the nucleus is broken up into number of small fragments. (iii) pyknosis, - nuclear material is condensed into a small deep-staining mass.

4. Hyaline degeneration, - chiefly affect the collagenous connective tissue in the walls of the seminiferous
tubules and in the intertubular tissue ultimately ending in fibrosis.

Exp. albino rat specimen 18\textsuperscript{V}, weighing 100 grms. was subjected to unilateral vasectomy on the right side with the contralateral side left undisturbed on 30.10.63. On the 7th day (6.11.63), the animal weighed 104.000 grms. and was autopsied. The ligatures on the resected vas deferens were carefully examined and found intact. The right testis and the epididymis weighed 0.900 grms. and 0.350 grms. respectively with the relative weight of the latter 1 in 2.571 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 0.800 grms. and 0.300 grms. respectively with the relative weight of the latter 1 in 2.667 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both right and left testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections reveal no material difference between the two testes. Neither testis shows any evidence of degeneration in the germinal epithelium. In both the testes, spermatogenic processes appear entirely normal, and spermatozoa are abundant. No hypertrophy or hyperplasia of interstitial cells is apparent in the vasectomized right testis. The sections of the right testis reveal,
however, small amount of exudates occupying chiefly the lumina of the tubules like those often found in the sections of testes in the normal animals under different species and classes. Both the testes, however, appear histologically quite normal.

Exp. albino rat specimen \(17^{V}_{M}\), weighing 98,000 grms. was subjected to unilateral vasectomy on the right side with a 'Mock' operation performed on the contralateral side on 30.10.63. On the 14th day (13.11.63), the animal weighed 100,000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The right testis and the epididymis weighed 0.820 grms. and 0.380 grms. respectively with the relative weight of the latter 1 in 2.168 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 0.800 grms. and 0.300 grms. respectively with the relative weight of the latter 1 in 2.667 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both right and left testes are detailed in Tables 3, 4, 8.

Histologic findings: Histologic picture in either testis is identical with that of a normal albino rat. The seminiferous tubules are occupied by a large number of spermatozoa and other sex cells, in different stages of evolution. In addition, a considerable number of Sertoli cells are visible. No evidence
of degeneration is present in either testis. No hypertrophy or hyperplasia of interstitial cells is apparent in the vasectomised right testis.

Exp. albino rat specimen 16M, weighing 130,000 grms. was subjected to vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 26.10.63. On the 33rd day (28.11.63), the animal weighed 133,000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. The left epididymis was found appreciably enlarged compared to that of the right side. No abnormalities were apparent in the testes. The left testis and the epididymis weighed 1.200 grms. and 0.520 grms. respectively with the relative weight of the latter 1 in 2.308 part of the former (Tables 6, 9 & Graph 1). The right testis and the epididymis weighed 1.155 grms. and 0.387 grms. respectively with the relative weight of the latter 1 in 2.984 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both right and left testes are detailed in Tables 3, 4, 8.

Histologic findings: The histological picture of the left testis is practically identical with that of the right testis. The seminal epithelium is normal and the spermatogenic cells show evidence of active spermatogenesis with the production of abundant spermatozoa. Neither testis shows evidence
of degeneration. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen 10V, weighing 145.000 grms. was subjected to bilateral vasectomy on 5.10.63. On the 54th day (28.11.63), the animal weighed 190.000 grms. and was autopsied. The ligatures on the resected vasa deferentia were found intact. No abnormalities were apparent in the testes. Both the epididymides were found somewhat enlarged compared to those of the control animal. The right testis and the epididymis weighed 1.051 grms. and 0.529 grms. respectively with the relative weight of the latter 1 in 1.986 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 1.140 grms. and 0.565 grms. respectively with the relative weight of the latter 1 in 2.018 part of the former (Tables 6, 9 & Graph 1). Dimensions and their averages in both right and left testes are detailed in Tables 4, 8.

Histologic findings: Microscopic sections of both the testes reveal slight amount of exudates accumulated inside the seminiferous tubules. Some of the seminiferous tubules are found undergoing degenerative changes whereas adjacent tubules exhibiting normal processes of spermatogenesis with the production of abundant spermatozoa. Many spermatozoa are, however, seen in the process of disintegration. In many tubules
spermatids, instead of becoming attached to the free ends of the Sertoli cells, fall into the lumina of the tubules, where they degenerate after an attempt to continue their normal evolution. Micrometric measurements as mentioned in Table 10 & Graph 2 include the micrometry of unaffected portions of both the testes. No hypertrophy or hyperplasia of interstitial cells is apparent in these testes.

Exp. albino rat specimen \(10^{\text{V}}\), weighing 143,000 grms. on 5.10.63 was maintained as a control animal against the exp. albino rat specimen \(10^{\text{V}}\) under similar conditions in every respect. On the 54th day (28.11.63), the animal weighed 200,000 grms. and was autopsied. No abnormalities were apparent in the testes. The right testis and the epididymis weighed 1.280 grms. and 0.410 grms. respectively with the relative weight of the latter 1 in 3.122 part of the former (Tables 5, 9 & Graph 1). The left testis and the epididymis weighed 1.300 grms. and 0.430 grms. respectively with the relative weight of the latter 1 in 3.023 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 8.

Histologic findings: Microscopic sections of the right and left testes reveal the features of normal seminal epithelium with plenty of spermatozoa not only within the seminiferous
tubules but also in the sections of epididymides in which spermatozoa are found occupying the lumina of vasa efferentia and epididymal tube.

Exp. albino rat specimen 12\(\frac{V}{V}\), weighing 150,000 grms. was subjected to bilateral vasectomy on 5.10.63. On the 74th day (18.12.63), the animal weighed 201,000 grms. and was autopsied. The ligatures on the resected vasa deferentia were found intact. The left testis was abnormally small and found occupying the abdominal cavity; it could not be replaced to the scrotum even by gentle pressure exerted upon it as it was partially adherent to the surrounding peritoneum. No abnormalities were apparent in the right testis. Only the right epididymis was found much enlarged compared to that of the control animal (specimen 12\(\frac{V}{V}\)C). The right testis and the epididymis weighed 1.270 grms. and 0.700 grms. respectively with the relative weight of the latter 1 in 1.814 part of the former (Table 6). The left testis and the epididymis weighed 0.645 grms. and 0.235 grms. respectively with the relative weight of the latter 1 in 2.745 part of the former (Table 6). Dimensions in both the right and left testes are detailed in Table 4.

Histologic findings: Microscopic sections of the left testis reveal extreme degree of degenerative changes in the germinal epithelium. Many of the seminiferous tubules are
entirely devoid of spermatogenic cells and completely fibrosed. The sections of the right testis reveal small amount of exudates with cell debris accumulated within the seminiferous tubules and in the intertubular spaces. Slight regressive or degenerative changes are evident in some of the tubules only. The bulk of the testis, however, consists of seminiferous tubules in active spermatogenesis. Considerable number of spermatozoa are visible in tubules of this testis. No hypertrophy or hyperplasia of the interstitial cells is apparent in either testis.

Exp. albino rat specimen 12\(\text{A}\), weighing 147.000 grms. on 5.10.63. was maintained as a control animal against exp. albino rat specimen 12\(\text{B}\) under similar conditions in every respect. On the 74th day (18.12.63), the animal weighed 201.000 grms. and was autopsied. No abnormalities were apparent in the testes. The right testis and the epididymis weighed 1.360 grms. and 0.410 grms. respectively with the relative weight of the latter 1 in 3.366 part of the former (Table 5). The left testis and the epididymis weighed 1.330 grms. and 0.420 grms. respectively with the relative weight of the latter 1 in 3.167 part of the former (Table 5). Dimensions in both the right and left testes are detailed in Table 3.

Histologic findings: Microscopic sections of both the right and left testes reveal characteristic picture of the normal seminal epithelium with abundance of spermatozoa. Sections of epididymides also display normal character.
The testes of exp. albino rats specimens \(12^V\) and \(12^C\) were excluded from the calculations in Tables and Graphs as the left testis of \(12^V\) was found grossly abnormal.

Exp. albino rat specimen \(15^V\), weighing 151.500 grms., was subjected to unilateral vasectomy on the left side with the contralateral side left undisturbed on 26.10.63. On the 78th day (12.2.64), the animal weighed 227.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The left epididymis was found much enlarged compared to that of the right side. The left testis and the epididymis weighed 1.550 grms. and 0.710 grms. respectively with the relative weight of the latter 1 in 2.184 part of the former (Tables 6, 9 & Graph 1). The right testis and the epididymis weighed 1.520 grms. and 0.450 grms. respectively with the relative weight of the latter 1 in 3.378 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the right and left testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections of the left testis reveal considerable amount of exudates both in the intra- and extratubular regions. A few seminiferous tubules exhibit degenerative changes in the germinal epithelium while a few adjacent tubules appear to be normal and show spermatozoa (fig. 6). The sections of the right testis, however,
reveal characteristic features of a normal testis with plenty of spermatozoa within the tubules and without any evidence of degeneration (fig. 5). The sections of both the epididymides show plenty of spermatozoa occupying the lumina of vas efferentia and epididymal canal. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen 14M, weighing 129.500 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 26.10.63. On the 97th day (31.1.64), the animal weighed 200.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. The left testis appeared abnormally enlarged with accumulation of fluid exudates beneath the tunica albuginea. The right testis was also found similarly enlarged but to a less extent. The left testis and the epididymis weighed 2.945 grms. and 0.695 grms. respectively with the relative weight of the latter 1 in 4.237 part of the former (Table 6). The right testis and the epididymis weighed 1.285 grms. and 0.370 grms. respectively with the relative weight of the latter 1 in 3.473 part of the former (Table 5). Dimensions of the testes are detailed in Tables 3, 4. The testes of this specimen 14M are excluded from the calculation in Tables and Graphs for statistical reasons.
Histologic findings: Microscopic sections of the left testis reveal heavy collection of exudates with cell debris everywhere including the space beneath the tunica albuginea. In some of the seminiferous tubules, the germinal epithelium has undergone degeneration to a considerable extent, while the seminiferous epithelium in some of the tubules is completely normal save in a few places where there is a tendency towards desquamation. The sections of the right testis also reveal similar accumulation of exudates with cell debris. Partial degeneration of the germinal epithelium in some of the tubules of this testis are also evident. No hyperplasia or hypertrophy of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen 9½, weighing 115.000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 5.10.63. On the 99th day (12.2.64), the animal weighed 243.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. Both the testes appeared abnormally enlarged with accumulation of fluid exudates beneath the tunica albuginea (fig. 1). The left epididymis was found much enlarged compared to that of the right side. The left testis and the epididymis weighed 2.970 grms. and 0.930 grms. respectively with the relative weight of the
latter 1 in 3.194 part of the former (Table 6). The right testis and the epididymis weighed 2.950 grms. and 0.429 grms. respectively with the relative weight of the latter 1 in 6.876 part of the former (Table 5). Dimensions of the testes are detailed in Tables 3, 4. Both the testes in this specimen were excluded from the calculation in the Tables and Graphs as they were grossly abnormal.

Histologic findings: Microscopic sections of the right testis (fig. 9) reveal excessive amount of exudates with degenerated cell debris in the intra-and extratubular regions. Some of the seminiferous tubules have undergone extensive degeneration, and many of them are found fibrosed. The sections of the left testis (fig. 10) reveal only slight amount of albuminous exudates. The seminiferous tubules that are situated at the central portion of the section appear practically normal whereas a few tubules at the periphery of the section are seen undergoing degenerative changes associated with fibrosis. Fibrotic changes, however, are more evident in the tubules of the right testis. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen 13M, weighing 138,000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 26.10. 63. On the 112th day (15.2.64), the animal weighed 195,000 grms.
and was autopsied. The ligatures on the resected vas deferens were found intact. Both the testes were found abnormally enlarged with accumulation of fluid exudates beneath the tunica albuginea (fig. 2). The left epididymis was much enlarged compared to that of the right side. The left testis and the epididymis weighed 2.440 grms. and 0.740 grms. respectively with the relative weight of the latter 1 in 3.298 part of the former (Table 6). The right testis and the epididymis weighed 2.720 grms. and 0.460 grms. respectively with the relative weight of the latter 1 in 5.913 part of the former (Table 5). Dimensions of the testes are detailed in Tables 3, 4. The testes of this specimen 13^M are excluded from the calculations in the Tables and Graphs for statistical reasons.

Histologic findings: Microscopic sections of the left testis (fig. 12) show accumulation of a good amount of exudates with debris chiefly occupying the intertubular space and extending into the region beneath the tunica albuginea and lifting the latter from the subjacent tissues in many a site. The germinal epithelium in a number of seminiferous tubules has undergone degeneration and many of the tubules are entirely devoid of spermatogenic cells and completely fibrosed whereas spermatogenic cells in a few tubules appear to be quite normal. The sections of the right testis (fig. 11) also show accumulation of exudates but to a lesser extent. Seminiferous
epithelium in a few tubules have undergone degeneration. In some of the tubules, however, plenty of spermatozoa with normal characteristics are visible. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen 11V, weighing 91,000 grms. was subjected to bilateral vasectomy on 5.10.63. On the 118th day (31.1.64), the animal weighed 220,000 grms. and was autopsied. The ligatures on the resected vasa deferentia were found intact. No abnormalities were apparent in the testes. A spermacyst was found formed at the head of the left epididymis (fig. 3). Both the epididymides were found much enlarged compared to those of the control animal. The right testis and the epididymis weighed 1.515 grms. and 0.660 grms. respectively with the relative weight of the latter 1 in 2.295 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 1.495 grms. and 0.690 grms. respectively with the relative weight of the latter 1 in 2.167 part of the former (Tables 6, 9 & Graph 1). Dimensions with their averages in both the testes are detailed in Tables 4, 8.

Histologic findings: Microscopic sections of both the testes (figs. 17, 18) reveal almost the same features like those of a normal testis. Degenerative changes in the sper-
matogenic cells are, however, visible most rarely in the tubules associated with slight fibrosis. Vast majority of the tubules are found quite normal with the presence of active spermatogenesis. Spermatozoa are found in the sections of both testes and also in the sections of epididymides where they are found occupying the vasa efferentia and epididymal canal. No hypertrophy or hyperplasia of the interstitial cells is apparent in both the testes. Micrometric measurements as mentioned in Table 10 & Graph 2 include the micrometry of unaffected portions of both the testes.

Exp. albino rat specimen 11^C, weighing 95.000 grms. on 5.10.63 was maintained as a control animal against the exp. albino rat specimen 11^V under similar conditions in every respect. On the 118th day (31.1.64), animal weighed 220.000 grms. and was autopsied. No abnormalities were apparent in the testes. The right testis and the epididymis weighed 0.995 grms. and 0.330 grms. respectively with the relative weight of the latter 1 in 3.015 part of the former (Tables 5, 9 & Graph 1). The left testis and the epididymis weighed 1.185 grms. and 0.370 grms. respectively with the relative weight of the latter 1 in 3.203 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 8.
Histologic findings: The histologic picture of either testis is similar to that in the normal albino rat. The seminal epithelium reveals all stages of spermatogenesis. No evidence of degeneration is present in either testis.

Exp. albino rat specimen $8^W_4$, weighing 103,000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 22.8.63. On the 127th day (27.12.63), the animal weighed 187,000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The left epididymis was found enlarged compared to that of the right side. The left testis and the epididymis weighed 1.442 grms. and 0.758 grms. respectively with the relative weight of the latter 1 in 1.902 part of the former (Tables 6, 9 & Graph 1). The right testis and the epididymis weighed 1.420 grms. and 0.460 grms. respectively with the relative weight of the latter 1 in 3.087 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections of both testes (figs. 13, 14) reveal characteristic features of a normal testis having well-formed stratified arrangement of spermatogenic cells. The process of spermatogenesis is active almost equally in both the testes, and spermatozoa in abundance are
The tails of spermatozoa are found forming typical whorls. Neither testis exhibits evidence of degeneration. Considerable amount of exudates is, however, present in the intertubular space of the left testis. Prominent and dilated blood vessels are also visible in the sections of the left testis. Spermatozoa occupying the lumina of vasa efferentia and epididymal canal are visible in the sections of both the epididymides (figs. 21, 22, 23). No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis. Micrometric measurements as mentioned in Table 10 & Graph 2 include the micrometry of both the testes.

Exp. albino rat specimen 7#, weighing 90.000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 22.8.63. On the 134th day (3.1.64), the animal weighed 149.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The left epididymis was found much enlarged compared to that of the right side. The left testis and the epididymis weighed 1.005 grms. and 0.670 grms. respectively with the relative weight of the latter 1 in 1.500 part of the former (Tables 6, 9 & Graph 1). The right testis and the epididymis weighed 1.000 grms. and 0.300 grms. respectively with the relative weight of the latter 1 in 3.333 part of the
Histologic findings: Histologic picture in either testis is identical with that of a normal albino rat. Seminiferous epithelium exhibits active spermatogenesis with the production of abundant spermatozoa. Spermatozoa are also visible in the lumina of the vasa efferentia and epididymal canal. No evidence of degenerative changes is present in either testis. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis. Micrometric measurements as mentioned in Table 10 & Graph 2 include the micrometry of only the right testis.

Exp. albino rat specimen 64V, weighing 120,000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 19.8.63. On the 143rd day (9.1.64), the animal weighed 190,000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The left epididymis was found much enlarged compared to that of the right side. The left testis and the epididymis weighed 1.310 grms. and 0.630 grms. respectively with the relative weight of the latter 1 in 2.079 part of the former (Tables 6, 9 & Graph 1). The right testis and the
epididymis weighed 1.050 grms. and 0.310 grms. respectively with the relative weight of the latter 1 in 3.387 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections of the right and left testes reveal insignificant amount of exudates accumulated in the intra- and extratubular spaces. Majority of the seminiferous tubules in either testis reveal varying degrees of degeneration in the germinal epithelium with complete fibrosis of the tubules in some instances. A very limited number of seminiferous tubules in either testis reveal, however, active spermatogenesis and considerable number of spermatozoa. Spermatozoa are also visible within the lumina of vasa efferentia and epididymal canal. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen 5\(\frac{1}{4}\), weighing 160.000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 19.8.63. On the 200th day (24.2.64), the animal weighed 265.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. The left testis was abnormally small and found occupying the abdominal cavity and adherent
to the surrounding peritoneum. The left epididymis was smaller than the right one. The left testis and the epididymis weighed 0.460 grms. and 0.320 grms. respectively with the relative weight of the latter 1 in 1.438 part of the former (Table 6). The right testis and the epididymis weighed 1.610 grms. and 0.450 grms. respectively with the relative weight of the latter 1 in 3.578 part of the former (Table 5). Dimensions of the testes are detailed in Tables 3, 4. The testes of this specimen SM, are excluded from the calculations in the Tables and Graphs for statistical reasons.

Histologic findings: Microscopic sections of the left testis (fig. 16) reveal complete degeneration associated with fibrosis of the seminiferous tubules. In some of the tubules, only a few spermatogonia and Sertoli cells are, however, visible. The sections of the right testis (fig. 15) reveal characteristic features of a normal testis with the production of plenty of spermatozoa. Considerable amount of exudates is visible, however, in the intertubular space. No evidence of degeneration is present in the right testis. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left testis.

Exp. albino rat specimen $3^V_0$, weighing 140,000 grms. was subjected to unilateral vasectomy on the right side with
the contralateral side left undisturbed on 30.5.63. On the 224th day (9.1.64), the animal weighed 298.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The right epididymis, however, was found enormously enlarged compared to that of the left side. The right testis and the epididymis weighed 1.265 grms. and 0.960 grms. respectively with the relative weight of the latter 1 in 1.318 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 1.375 grms. and 0.440 grms. respectively with the relative weight of the latter 1 in 3.125 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections of the right and left testes reveal small collection of exudates with cell debris. Considerable degenerative changes of the germinal epithelium are present in some of the tubules in both the testes. Many of the seminiferous tubules, however, show active spermatogenesis and abundance of spermatozoa. Spermatozoa are also evident in the lumina of the vasa efferentia and epididymal canal. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised right testis. Micrometric measurements as mentioned in Table 10 & Graph 2 include the micrometry of unaffected portions of both the testes.
Exp. albino rat specimen 426, weighing 105.000 grms. was subjected to unilateral vasectomy on the left side with a 'Mock' operation performed on the contralateral side on 10.6.63. On the 259th day (24.2.64), the animal weighed 218.000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The left epididymis, however, was found much enlarged compared to that of the right side. The left testis and the epididymis weighed 1.090 grms. and 0.660 grms. respectively with the relative weight of the latter 1 in 1.652 part of the former (Tables 6, 9 & Graph 1). The right testis and the epididymis weighed 1.150 grms. and 0.345 grms. respectively with the relative weight of the latter 1 in 3.578 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections of both the right and left testes reveal features of the seminal epithelium of a normal testis. Spermatogenic cells are in the process of active spermatogenesis, and plenty of spermatozoa are found in the seminiferous tubules of the testes. Accumulation of an insignificant amount of albuminous exudates is visible in the sections of the right testis. No evidence of degeneration is present in either testis. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised left
testis. Micrometric measurements as mentioned in Table 10 & Graph 2 include the micrometry of both the testes.

Exp. albino rat specimen 2\textsuperscript{v}, weighing 181.000 grms. was subjected to bilateral vasectomy on 24.5.63. On the 276th day (24.2.64), the animal weighed 255.000 grms. and was autopsied. The ligatures on the resected vasa deferentia were found intact. No abnormalities were apparent in the testes. A spermacyst, however, was found on the testicular side of the left vas deferens appreciably proximal to the site of ligation and resection (fig. 4). Both the epididymides were found much enlarged compared to those of the control animal. The right testis and the epididymis weighed 1.450 grms. and 0.820 grms. respectively with the relative weight of the latter 1 in 1.768 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 1.415 grms. and 0.835 grms. respectively with the relative weight of the latter 1 in 1.695 part of the former (Tables 6, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 4, 8.

Histologic findings: Microscopic sections of the right and left testes (figs. 19, 20) reveal the features of seminiferous epithelium of a normal testis. The seminiferous epithelium in both the testes exhibits active spermatogenesis with the production of abundant spermatozoa, the tails of which are seen to have formed typical whorls in many a tubule. Accumu-
lation of slight amount of exudates with cell debris are visible, especially in the sections of left testis, but no evidence of degenerative changes are present in the sections of either testis. No hypertrophy or hyperplasia of the interstitial cells is apparent. In the sections of epididymides, spermatozoa are visible in the lumina of vasa efferentia and epididymal canal.

Exp. albino rat specimen 2\textsuperscript{VC}, weighing 185,000 grms. was maintained as a control animal against the exp. albino rat specimen 2\textsuperscript{V} under similar conditions in every respect. On the 276th day (24.2.64), the animal weighed 287,000 grms. and was autopsied. No abnormalities were apparent in the testes. The right testis and the epididymis weighed 1,500 grms. and 0.460 grms. respectively with the relative weight of the latter 1 in 3.261 part of the former (Tables 5, 9 & Graph 1). The left testis and the epididymis weighed 1,570 grms. and 0.465 grms. respectively with the relative weight of the latter 1 in 3.376 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes were detailed in Tables 3, 8.

Histologic findings: Histologic pictures in the right and left testes are similar to those of a normal albino rat. Active spermatogenesis with the production of abundant spermatozoa, the tails of which are mostly arranged in whorls
are evident in either testis. No evidence of degeneration is discernible in the testes.

Exp. albino rat specimen 1\(\frac{V}{U}\), weighing 130,000 grms. was subjected to unilateral vasectomy on the right side with the contralateral side left undisturbed on 4.5.63. On the 298th day (26.2.64), the animal weighed 230,000 grms. and was autopsied. The ligatures on the resected vas deferens were found intact. No abnormalities were apparent in the testes. The right epididymis was found much enlarged compared to that of the left side. The right testis and the epididymis weighed 1.560 grms. and 0.750 grms. respectively with the relative weight of the latter 1 in 2.080 part of the former (Tables 6, 9 & Graph 1). The left testis and the epididymis weighed 1.500 grms. and 0.450 grms. respectively with the relative weight 1 in 3.333 part of the former (Tables 5, 9 & Graph 1). Dimensions and their averages in both the testes are detailed in Tables 3, 4, 8.

Histologic findings: Microscopic sections of the right testis (fig. 7) reveal extensive degenerative changes which have involved most of the seminiferous tubules. Stratified character of seminiferous epithelium is found, however, in a few tubules but with rare presence of spermatozoa. The sections of the left testis (fig. 8) reveal, however, active spermatogenesis with the production of spermatozoa in abundance in majority of the
seminiferous tubules. A few tubules are seen to have been degenerated and completely fibrosed. Considerable amount of exudates mixed up with cell debris is also present in the sections of the left testis. No hypertrophy or hyperplasia of the interstitial cells is apparent in the vasectomised right testis.
PART II

TABLES
### PART II: TABLE NO. 1

**TABLE SHOWING BODY WEIGHT, THE ABSOLUTE WEIGHT OF TESTIS, THE RELATIVE WEIGHT OF TESTIS IN PROPORTION TO BODY WEIGHT, AND THE WEIGHT OF TESTIS PER KILOGRAM OF BODY WEIGHT, IN DIFFERENT TYPES OF "CONTROL" TESTES IN EXPERIMENTAL ALBINO RATS STUDIED IN THE PRESENT WORK**

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp; DAYS FOLLOWING VASECTOMY</th>
<th>BODY WT. AT THE TIME OF SACRIFICE IN GRMS.</th>
<th>WT. OF TESTIS IN GRMS.</th>
<th>RELATIVE WT. OF RT. TESTIS TO BODY WT.</th>
<th>WT. OF RT. TESTIS PER KG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 (7 days)</td>
<td>104.000</td>
<td>0.300</td>
<td>1 in 130.000 part of body wt.</td>
<td>7.692</td>
</tr>
<tr>
<td>17 (14 n)</td>
<td>100.000</td>
<td>0.800</td>
<td>125.000</td>
<td>8.000</td>
</tr>
<tr>
<td>16 (33 n)</td>
<td>133.000</td>
<td>1.155</td>
<td>115.152</td>
<td>8.684</td>
</tr>
<tr>
<td>10 (54 n)</td>
<td>200.000</td>
<td>1.280</td>
<td>156.260</td>
<td>6.400</td>
</tr>
<tr>
<td>**12 (74 n)</td>
<td>204.000</td>
<td>1.280</td>
<td>147.826</td>
<td>6.766</td>
</tr>
<tr>
<td>**15 (78 n)</td>
<td>227.000</td>
<td>1.520</td>
<td>149.342</td>
<td>6.696</td>
</tr>
<tr>
<td>**14 (97 n)</td>
<td>200.000</td>
<td>1.285</td>
<td>155.642</td>
<td>6.425</td>
</tr>
<tr>
<td>**9 (99 n)</td>
<td>243.000</td>
<td>2.250</td>
<td>82.373</td>
<td>12.140</td>
</tr>
<tr>
<td>**18 (112 n)</td>
<td>195.000</td>
<td>2.720</td>
<td>71.691</td>
<td>13.949</td>
</tr>
<tr>
<td>11 (118 n)</td>
<td>218.000</td>
<td>0.995</td>
<td>219.095</td>
<td>4.564</td>
</tr>
<tr>
<td>8 (127 n)</td>
<td>187.000</td>
<td>1.420</td>
<td>131.690</td>
<td>7.594</td>
</tr>
</tbody>
</table>

*(Contd....)*
** PART II : TABLE NO. 1 (Contd.)**

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp; DAYS FOLLOWING VASECTOMY</th>
<th>BODY WT. AT THE TIME OF SACRIFICE IN GRMS.</th>
<th>WT. OF TESTIS IN GRMS.</th>
<th>RELATIVE WT. OF TESTIS IN PROPORTION TO BODY WT.</th>
<th>WT. OF TESTIS WT. IN GRMS. PER KG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7$^V$ (134 days) 149.000</td>
<td>1.000</td>
<td>1 in 149.000 part of body wt.</td>
<td></td>
<td>6.711</td>
</tr>
<tr>
<td>6$^V$ (143 &quot; ) 190.000</td>
<td>1.050</td>
<td>180.952 &quot;</td>
<td></td>
<td>5.526</td>
</tr>
<tr>
<td>** 5$^V$ (200 &quot; ) 265.000</td>
<td>1.610</td>
<td>164.596 &quot;</td>
<td></td>
<td>6.075</td>
</tr>
<tr>
<td>3$^U$ (224 &quot; ) 298.000</td>
<td>1.375</td>
<td>216.727 &quot;</td>
<td></td>
<td>4.614</td>
</tr>
<tr>
<td>4$^V$ (259 &quot; ) 218.000</td>
<td>1.150</td>
<td>189.565 &quot;</td>
<td></td>
<td>5.275</td>
</tr>
<tr>
<td>2$^V$ (276 &quot; ) 268.000</td>
<td>1.500</td>
<td>178.667 &quot;</td>
<td></td>
<td>5.597</td>
</tr>
<tr>
<td>1$^V$ (298 &quot; ) 230.000</td>
<td>1.500</td>
<td>153.333 &quot;</td>
<td></td>
<td>6.522</td>
</tr>
<tr>
<td>AVERAGE : 194.000</td>
<td>1.225</td>
<td>158.367 &quot;</td>
<td></td>
<td>6.354</td>
</tr>
</tbody>
</table>

** Double asterisks = unusual cases (excluded from calculations).**

Different Types of "CONTROL" tests:

M = Testis of the side in which "Mock" operation performed.

U = Testis of the side in which no interference done i.e., the testis left untouched.

V = Testes of both sides in separate animals that were maintained as "Control" against bilaterally vasectomised cases.
### PART II: TABLE NO. 2

**TABLE SHOWING BODY WEIGHT, THE ABSOLUTE WEIGHT OF TESTIS, THE RELATIVE WEIGHT OF TESTIS IN PROPORTION TO BODY WEIGHT, AND THE WEIGHT OF TESTIS PER KILOGRAM OF BODY WEIGHT, IN VASECTOMISED TESTES IN EXPERIMENTAL ALBINO RATS STUDIED IN THE PRESENT WORK**

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp; VASECTOMY</th>
<th>BODY WT. AT SACRIFICE</th>
<th>WT. OF TESTIS AT TIME OF TESTIS</th>
<th>RELATIVE WT. OF TESTIS IN PROPORTION TO BODY WT.</th>
<th>WT. OF TESTIS IN GRMS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18_V_U (7 days)</td>
<td>104.000</td>
<td>0.900</td>
<td>1 in 115.556 part of body wt.</td>
<td>8.654</td>
</tr>
<tr>
<td>17_V_M (14)</td>
<td>100.000</td>
<td>0.820</td>
<td>121.951</td>
<td>8.200</td>
</tr>
<tr>
<td>16_V_V (33)</td>
<td>133.000</td>
<td>1.200</td>
<td>110.833</td>
<td>9.023</td>
</tr>
<tr>
<td>10_V_V (54)</td>
<td>190.000</td>
<td>1.051</td>
<td>189.780</td>
<td>5.532</td>
</tr>
<tr>
<td>** 12_V_V (74)</td>
<td>201.000</td>
<td>1.270</td>
<td>158.268</td>
<td>6.318</td>
</tr>
<tr>
<td>15_V_U (78)</td>
<td>227.000</td>
<td>1.550</td>
<td>146.452</td>
<td>6.828</td>
</tr>
<tr>
<td>** 14_V_M (97)</td>
<td>200.000</td>
<td>2.945</td>
<td>67.912</td>
<td>12.725</td>
</tr>
<tr>
<td>** 9_V_V (99)</td>
<td>243.000</td>
<td>2.970</td>
<td>81.818</td>
<td>12.222</td>
</tr>
<tr>
<td>** 13_V_V (112)</td>
<td>195.000</td>
<td>2.440</td>
<td>79.918</td>
<td>12.513</td>
</tr>
<tr>
<td>11_V_V (118)</td>
<td>220.000</td>
<td>1.595</td>
<td>145.215</td>
<td>6.886</td>
</tr>
<tr>
<td>** 8_V_M (127)</td>
<td>187.000</td>
<td>1.442</td>
<td>129.681</td>
<td>7.711</td>
</tr>
</tbody>
</table>

(Contd......)
**PART II : TABLE NO. 2 (Contd.)**

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp;</th>
<th>BODY WT. AT THE TIME OF SACRIFICE IN GRMS.</th>
<th>WT. OF TESTIS IN GRMS.</th>
<th>RELATIVE WT. OF TESTIS IN PROPORTION TO BODY WT.</th>
<th>WT. OF TESTIS PER KG. OF BODY WT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7M V (134 days)</td>
<td>149.000</td>
<td>1.005</td>
<td>1 in 148.259 part of body wt.</td>
<td>6.745</td>
</tr>
<tr>
<td>6M V (143 &quot; )</td>
<td>190.000</td>
<td>1.310</td>
<td>145.038 &quot;</td>
<td>6.894</td>
</tr>
<tr>
<td>**5M V (200 &quot; )</td>
<td>265.000</td>
<td>0.460</td>
<td>576.087 &quot;</td>
<td>1.736</td>
</tr>
<tr>
<td>3V U (224 &quot; )</td>
<td>293.000</td>
<td>1.265</td>
<td>235.573 &quot;</td>
<td>4.245</td>
</tr>
<tr>
<td>4M V (259 &quot; )</td>
<td>218.000</td>
<td>1.090</td>
<td>200.000 &quot;</td>
<td>5.000</td>
</tr>
<tr>
<td>2V V (276 &quot; )</td>
<td>255.000</td>
<td>1.450</td>
<td>175.862 &quot;</td>
<td>5.686</td>
</tr>
<tr>
<td>1V U (293 &quot; )</td>
<td>230.000</td>
<td>1.560</td>
<td>147.436 &quot;</td>
<td>6.783</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>192.385</strong></td>
<td><strong>1.263</strong></td>
<td><strong>152.324</strong> &quot;</td>
<td><strong>6.658</strong></td>
</tr>
</tbody>
</table>

**Double asterisks = unusual cases (excluded from calculations).**

"VASECTOMISED" testes:

V = Testis of the side in which unilateral vasectomy performed.

V V = Testes of both sides in which bilateral vasectomy performed.
### TABLE NO. 3

**TABLE SHOWING THE DIMENSIONS OF TESTIS AND THE SPECIFIC GRAVITY OF TESTIS TISSUE IN THE SAME SERIES OF "CONTROL" TESTES AS IN PART II: TABLE NO. 1**

<table>
<thead>
<tr>
<th>NO. &amp; DAYS AFTER VASECTOMY</th>
<th>SPECIMEN</th>
<th>LENGTH IN CM.</th>
<th>BREADTH IN CM.</th>
<th>DORSO-VENTRAL DIAMETER IN CM.</th>
<th>SPECIFIC GRAVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>18V</td>
<td>(7 days)</td>
<td>1.700</td>
<td>0.700</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>17V</td>
<td>(14 &quot;</td>
<td>1.800</td>
<td>0.600</td>
<td>0.750</td>
<td>1.000</td>
</tr>
<tr>
<td>16V</td>
<td>(33 &quot;</td>
<td>1.850</td>
<td>1.050</td>
<td>1.000</td>
<td>1.155</td>
</tr>
<tr>
<td>10V</td>
<td>(54 &quot;</td>
<td>1.900</td>
<td>0.900</td>
<td>1.150</td>
<td>1.181</td>
</tr>
<tr>
<td><strong>12V</strong></td>
<td>(74 &quot;</td>
<td>1.930</td>
<td>1.010</td>
<td>1.150</td>
<td><strong>1.061</strong></td>
</tr>
<tr>
<td><strong>15V</strong></td>
<td>(78 &quot;</td>
<td>2.220</td>
<td>1.200</td>
<td>1.300</td>
<td><strong>1.074</strong></td>
</tr>
<tr>
<td><strong>14V</strong></td>
<td>(97 &quot;</td>
<td>1.910</td>
<td>1.090</td>
<td>1.250</td>
<td><strong>1.285</strong></td>
</tr>
<tr>
<td><strong>9V</strong></td>
<td>(99 &quot;</td>
<td>2.720</td>
<td>1.400</td>
<td>1.560</td>
<td><strong>1.160</strong></td>
</tr>
<tr>
<td><strong>13V</strong></td>
<td>(112 &quot;</td>
<td>2.650</td>
<td>1.400</td>
<td>1.510</td>
<td><strong>1.045</strong></td>
</tr>
<tr>
<td><strong>11V</strong></td>
<td>(118 &quot;</td>
<td>1.650</td>
<td>0.960</td>
<td>1.160</td>
<td><strong>1.106</strong></td>
</tr>
<tr>
<td>3V</td>
<td>(127 &quot;</td>
<td>2.080</td>
<td>1.210</td>
<td>1.330</td>
<td><strong>1.291</strong></td>
</tr>
<tr>
<td>7V</td>
<td>(134 &quot;</td>
<td>1.850</td>
<td>1.050</td>
<td>1.210</td>
<td><strong>1.050</strong></td>
</tr>
<tr>
<td>6V</td>
<td>(143 &quot;</td>
<td>1.860</td>
<td>1.050</td>
<td>1.100</td>
<td><strong>1.150</strong></td>
</tr>
</tbody>
</table>

(Contd...)
** Double asterisks = unusual cases (excluded from calculations).

Different types of "CONTROL" testes:

M = Testis of the side in which "Mock" operation performed.

U = Testis of the side in which no interference done i.e.,
the testis left untouched.

V = Testes of both sides in separate animals that were
maintained as "Control" against bilaterally vasectomy cases.

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp; DAYS FOLLOWING VASECTOMY</th>
<th>LENGTH IN CM.</th>
<th>BREADTH IN CM.</th>
<th>DORSO-VENTRAL DIAMETER IN CM.</th>
<th>SPECIFIC GRAVITY OF TESTIS TISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M (200 days)</strong></td>
<td>2.210</td>
<td>1.210</td>
<td>1.320</td>
<td>1.463</td>
</tr>
<tr>
<td>3U (224)</td>
<td>2.200</td>
<td>1.150</td>
<td>1.200</td>
<td>1.057</td>
</tr>
<tr>
<td>4M (259)</td>
<td>1.950</td>
<td>1.110</td>
<td>1.200</td>
<td>1.046</td>
</tr>
<tr>
<td>2V (276)</td>
<td>2.000</td>
<td>1.180</td>
<td>1.270</td>
<td>1.200</td>
</tr>
<tr>
<td>1U (298)</td>
<td>2.050</td>
<td>1.150</td>
<td>1.350</td>
<td>1.064</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td>1.944</td>
<td>1.032</td>
<td>1.169</td>
<td>1.121</td>
</tr>
</tbody>
</table>
### PART II: TABLE NO. 4

**TABLE SHOWING THE DIMENSIONS OF TESTIS AND THE SPECIFIC GRAVITY OF TESTIS TISSUE IN THE SAME SERIES OF VASECTOMISED TESTES AS IN PART II: TABLE NO. 2**

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp;</th>
<th>LENGTH IN CM.</th>
<th>BREADTH IN CM.</th>
<th>DORSO-VENTRAL DIAMETER IN CM.</th>
<th>SPECIFIC GRAVITY OF TESTIS TISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAYS AFTER VASECTOMY</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>18²/₃ (7 days)</td>
<td>1.700</td>
<td>0.800</td>
<td>1.100</td>
<td>1.020</td>
</tr>
<tr>
<td>17²/₃ (14 &quot; )</td>
<td>1.800</td>
<td>0.700</td>
<td>0.820</td>
<td>1.025</td>
</tr>
<tr>
<td>16²/₃ (33 &quot; )</td>
<td>2.010</td>
<td>1.050</td>
<td>1.100</td>
<td>1.004</td>
</tr>
<tr>
<td>10²/₃ (54 &quot; )</td>
<td>1.850</td>
<td>0.950</td>
<td>0.950</td>
<td>1.140</td>
</tr>
<tr>
<td><strong>12²/₃ (74 &quot; )</strong></td>
<td>2.100</td>
<td>1.120</td>
<td>1.200</td>
<td>1.154</td>
</tr>
<tr>
<td>15²/₃ (78 &quot; )</td>
<td>2.260</td>
<td>1.200</td>
<td>1.320</td>
<td>1.180</td>
</tr>
<tr>
<td><strong>14²/₃ (97 &quot; )</strong></td>
<td>2.710</td>
<td>1.400</td>
<td>1.530</td>
<td>1.172</td>
</tr>
<tr>
<td><strong>9²/₃ (99 &quot; )</strong></td>
<td>2.800</td>
<td>1.300</td>
<td>1.400</td>
<td>1.024</td>
</tr>
<tr>
<td><strong>13²/₃ (112 &quot; )</strong></td>
<td>2.550</td>
<td>1.390</td>
<td>1.490</td>
<td>1.016</td>
</tr>
<tr>
<td>11²/₃ (118 &quot; )</td>
<td>2.210</td>
<td>1.180</td>
<td>1.280</td>
<td>1.261</td>
</tr>
<tr>
<td>8²/₃ (127 &quot; )</td>
<td>2.050</td>
<td>1.190</td>
<td>1.310</td>
<td>1.299</td>
</tr>
<tr>
<td>7²/₃ (134 &quot; )</td>
<td>1.950</td>
<td>1.100</td>
<td>1.160</td>
<td>1.116</td>
</tr>
<tr>
<td>6²/₃ (143 &quot; )</td>
<td>2.300</td>
<td>1.150</td>
<td>1.300</td>
<td>1.154</td>
</tr>
</tbody>
</table>

(Contd.......)
### PART II: TABLE NO. 4 (Contd.)

<table>
<thead>
<tr>
<th>SPECIMEN</th>
<th>LENGTH IN CM.</th>
<th>BREADTH IN CM.</th>
<th>DORSO-VENTRAL DIAMETER IN CM.</th>
<th>SPECIFIC GRAVITY OF TESTIS TISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAYS AFTER VASECTOMY</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
</tr>
<tr>
<td>VASECTOMY</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
</tr>
<tr>
<td><strong>5(_V) (200 days)</strong></td>
<td>1.500</td>
<td>0.700</td>
<td>0.900</td>
<td>1.179</td>
</tr>
<tr>
<td><strong>3(_V) (224 &quot; )</strong></td>
<td>1.390</td>
<td>1.150</td>
<td>1.300</td>
<td>1.054</td>
</tr>
<tr>
<td><strong>4(_V) (259 &quot; )</strong></td>
<td>1.950</td>
<td>1.110</td>
<td>1.150</td>
<td>1.212</td>
</tr>
<tr>
<td><strong>2(_V) (276 &quot; )</strong></td>
<td>2.070</td>
<td>1.200</td>
<td>1.300</td>
<td>1.300</td>
</tr>
<tr>
<td><strong>1(_V) (298 &quot; )</strong></td>
<td>2.300</td>
<td>1.260</td>
<td>1.300</td>
<td>1.150</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>2.034</td>
<td>1.088</td>
<td>1.190</td>
<td>1.139</td>
</tr>
</tbody>
</table>

** Double asterisks = unusual cases (excluded from calculations).

"VASECTOMISED" testes:

\(_V\) = Testis of the side in which unilateral vasectomy performed.

\(_V\) = Testes of both sides in which bilateral vasectomy performed.
### PART II: TABLE NO. 5

**TABLE SHOWING THE ABSOLUTE WEIGHT OF TESTIS AND EPIDIDYMIS, AND THE RELATIVE WEIGHT OF THE EPIDIDYMIS IN PROPORTION TO TESTIS WEIGHT, IN THE SAME SERIES OF "CONTROL" TESTES AS IN PART II: TABLE NO. 1.**

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp; DAYS</th>
<th>WT. OF TESTIS</th>
<th>WT. OF EPIDIDYMIS</th>
<th>RELATIVE WT. OF EPIDIDYMIS IN PROPORTION TO TESTIS WT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOLLOWING VASECTOMY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
<td>LT. EPIDIDYMIS</td>
<td></td>
</tr>
<tr>
<td>SPECIMEN</td>
<td>WT. IN GRMS.</td>
<td>WEI GHT IN GRMS.</td>
<td>IN PROPORTION TO RT. TESTIS BI, TESTIS TESTIS WT.</td>
</tr>
<tr>
<td>18\textsuperscript{V} (7 days)</td>
<td>0.800</td>
<td>0.300</td>
<td>1 in 2.667 part of testis wt.</td>
</tr>
<tr>
<td>17\textsuperscript{V} (14 &quot; )</td>
<td>0.800</td>
<td>0.300</td>
<td>&quot; 2.667 &quot;</td>
</tr>
<tr>
<td>16\textsuperscript{V} (33 &quot; )</td>
<td>1.155</td>
<td>0.387</td>
<td>&quot; 2.984 &quot;</td>
</tr>
<tr>
<td>10\textsuperscript{V} (54 &quot; )</td>
<td>1.280</td>
<td>0.410</td>
<td>&quot; 3.122 &quot;</td>
</tr>
<tr>
<td>** 12\textsuperscript{V} (74 &quot; )</td>
<td>1.380</td>
<td>0.410</td>
<td>&quot; 3.366 &quot;</td>
</tr>
<tr>
<td>15\textsuperscript{V} (78 &quot; )</td>
<td>1.520</td>
<td>0.450</td>
<td>&quot; 3.378 &quot;</td>
</tr>
<tr>
<td>** 14\textsuperscript{V} (97 &quot; )</td>
<td>1.285</td>
<td>0.370</td>
<td>&quot; 3.473 &quot;</td>
</tr>
<tr>
<td>** 9\textsuperscript{V} (99 &quot; )</td>
<td>2.950</td>
<td>0.420</td>
<td>&quot; 6.876 &quot;</td>
</tr>
<tr>
<td>** 13\textsuperscript{V} (112 &quot; )</td>
<td>2.720</td>
<td>0.460</td>
<td>&quot; 5.913 &quot;</td>
</tr>
<tr>
<td>** 11\textsuperscript{V} (118 &quot; )</td>
<td>0.925</td>
<td>0.330</td>
<td>&quot; 3.015 &quot;</td>
</tr>
<tr>
<td>** 8\textsuperscript{V} (127 &quot; )</td>
<td>1.420</td>
<td>0.460</td>
<td>&quot; 3.087 &quot;</td>
</tr>
<tr>
<td>** 7\textsuperscript{V} (134 &quot; )</td>
<td>1.000</td>
<td>0.300</td>
<td>&quot; 3.333 &quot;</td>
</tr>
<tr>
<td>** 6\textsuperscript{V} (143 &quot; )</td>
<td>1.050</td>
<td>0.310</td>
<td>&quot; 3.387 &quot;</td>
</tr>
</tbody>
</table>

(Centd.......)
** PART II : TABLE NO. 5 (Contd.) **

<table>
<thead>
<tr>
<th>SPECIMEN NO. &amp; DAYS</th>
<th>SPECIMEN WT. IN GRMS.</th>
<th>WT. OF TESTIS IN GRMS.</th>
<th>WT. OF EPIDIDYMIS IN GRMS.</th>
<th>RELATIVE WT. OF EPIDIDYMIS TO FOLLOWING RT. TESTIS WT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ½ (200 days)</td>
<td>1.610</td>
<td>0.450</td>
<td></td>
<td>1 in 3.578 part of testis wt.</td>
</tr>
<tr>
<td>3 ½ (224 )</td>
<td>1.375</td>
<td>0.440</td>
<td></td>
<td>3.125</td>
</tr>
<tr>
<td>4 ½ (259 )</td>
<td>1.150</td>
<td>0.345</td>
<td></td>
<td>3.578</td>
</tr>
<tr>
<td>2 ½ (276 )</td>
<td>1.500</td>
<td>0.460</td>
<td></td>
<td>3.261</td>
</tr>
<tr>
<td>1 ½ (298 )</td>
<td>1.500</td>
<td>0.450</td>
<td></td>
<td>3.333</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>1.225</td>
<td>0.388</td>
<td></td>
<td>3.157</td>
</tr>
</tbody>
</table>

** Double asterisks = unusual cases (excluded from calculations). **

Different types of "CONTROL" testes:

- **M** = Testis of the side in which "Mock" operation performed.
- **U** = Testis of the side in which no interference done i.e., the testis left untouched.
- **V/C** = Testes of both sides in separate animals that were maintained as "Control" against bilaterally vasectomised cases.
## TABLE SHOWING THE ABSOLUTE WEIGHT OF TESTIS AND EPIDIDYMIS,
AND THE RELATIVE WEIGHT OF THE EPIDIDYMIS IN PROPORTION
TO TESTIS WEIGHT, IN THE SAME SERIES OF VASECTOMISED
TESTES AS IN PART III: TABLE NO. 2

<table>
<thead>
<tr>
<th>SPECIMEN</th>
<th>WT. OF TESTIS</th>
<th>WT. OF EPIDIDYMIS</th>
<th>RELATIVE WT. OF EPIDIDYMIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT. IN GRMS.</td>
<td>RT. TESTIS</td>
<td>LT. TESTIS</td>
<td>WT. IN GRMS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIMEN</th>
<th>WT. OF TESTIS</th>
<th>WT. OF EPIDIDYMIS</th>
<th>RELATIVE WT. OF EPIDIDYMIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>18(N) (7 days)</td>
<td>0.900</td>
<td>0.350</td>
<td>1 in 2.571 part of testis wt.</td>
</tr>
<tr>
<td>17(N) (14&quot;)</td>
<td>0.820</td>
<td>0.330</td>
<td>2.158</td>
</tr>
<tr>
<td>16(N) (33&quot;)</td>
<td>1.200</td>
<td>0.520</td>
<td>2.308</td>
</tr>
<tr>
<td>10(N) (54&quot;)</td>
<td>1.051</td>
<td>0.529</td>
<td>1.936</td>
</tr>
<tr>
<td>12(N) (74&quot;)</td>
<td>1.270</td>
<td>0.700</td>
<td>1.814</td>
</tr>
<tr>
<td>15(N) (78&quot;)</td>
<td>1.550</td>
<td>0.710</td>
<td>2.134</td>
</tr>
<tr>
<td>14(N) (97&quot;)</td>
<td>2.945</td>
<td>0.695</td>
<td>4.227</td>
</tr>
<tr>
<td>9(N) (99&quot;)</td>
<td>2.970</td>
<td>0.930</td>
<td>3.194</td>
</tr>
<tr>
<td>**13(N) (112&quot;)</td>
<td>2.440</td>
<td>0.740</td>
<td>3.238</td>
</tr>
<tr>
<td>11(N) (118&quot;)</td>
<td>1.515</td>
<td>0.660</td>
<td>2.205</td>
</tr>
<tr>
<td>8(N) (127&quot;)</td>
<td>1.442</td>
<td>0.758</td>
<td>1.902</td>
</tr>
<tr>
<td>7(N) (134&quot;)</td>
<td>1.005</td>
<td>0.670</td>
<td>1.500</td>
</tr>
<tr>
<td>6(N) (143&quot;)</td>
<td>1.310</td>
<td>0.630</td>
<td>2.079</td>
</tr>
</tbody>
</table>

(Contd. . . .)
### PART II: TABLE NO. 6 (Contd.)

<table>
<thead>
<tr>
<th>SPECIMEN</th>
<th>WT. OF TESTIS</th>
<th>WT. OF EPIDIDYMIS</th>
<th>RELATIVE WT. OF EPIDIDYMIS</th>
<th>WT. OF TESTIS</th>
<th>WT. OF EPIDIDYMIS</th>
<th>RELATIVE WT. OF EPIDIDYMIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5(\text{V})</strong> (200 days)</td>
<td>0.460</td>
<td>0.320</td>
<td>1 in 1.438 part of testis wt.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3(\text{V}) (224 &quot; )</td>
<td>1.265</td>
<td>0.960</td>
<td>&quot; 1.318 &quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4(\text{V}) (259 &quot; )</td>
<td>1.090</td>
<td>0.860</td>
<td>&quot; 1.252 &quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2(\text{V}) (276 &quot; )</td>
<td>1.450</td>
<td>0.820</td>
<td>&quot; 1.768 &quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1(\text{V}) (298 &quot; )</td>
<td>1.560</td>
<td>0.750</td>
<td>&quot; 2.080 &quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AVERAGE</strong>:</td>
<td>1.263</td>
<td>0.655</td>
<td>&quot; 1.928 &quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Double asterisks = unusual cases (excluded from calculations). **

"VASECTOMISED" testes:

\(\text{V}\) = Testis of the side in which unilateral vasectomy performed.

\(\text{V}\) = Testes of both sides in which bilateral vasectomy performed.
PART II: TABLE NO. 7

TABLE SHOWING THE AVERAGE BODY WEIGHT, THE AVERAGE WEIGHT OF TESTES, THE AVERAGE RELATIVE WEIGHT OF TESTES IN PROPORTION TO BODY WEIGHT, AND THE AVERAGE WEIGHT OF TESTES PER KILOGRAM OF AVERAGE BODY WEIGHT, IN DIFFERENT TYPES OF "CONTROL" AND "VASECTOMISED" TESTES IN EXPERIMENTAL ALBINO RATS STUDIED IN THE PRESENT WORK.

<table>
<thead>
<tr>
<th>IN RESPECT OF</th>
<th>RANGE OF BODY WT. IN GRMS.</th>
<th>AVERAGE BODY WT.</th>
<th>RANGE OF TESTIS WT. IN GRMS.</th>
<th>AVERAGE TESTIS WT.</th>
<th>AVERAGE RELATIVE WT. OF TESTIS IN PROPORTION TO AVERAGE BODY WT.</th>
<th>AVERAGE TESTIS WT. IN GRMS. PER KG. OF AVERAGE BODY WT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) DIFFERENT TYPES OF &quot;CONTROL&quot; TESTES</td>
<td>100 to 298</td>
<td>194.00 to 1.570</td>
<td>1.225 in 158.367 part of body wt.</td>
<td>6.354</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) &quot;VASECTOMISED&quot; TESTES</td>
<td>100 to 298</td>
<td>192.385 to 1.560</td>
<td>1.263 &quot; 152.324 &quot;</td>
<td>6.658</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### PART II: TABLE NO. 8

TABLE SHOWING THE AVERAGE DIMENSIONS OF TESTES, AND THE AVERAGE SPECIFIC GRAVITY OF TESTIS TISSUE IN DIFFERENT TYPES OF “CONTROL” AND “VASECTOMISED” TESTES IN EXPERIMENTAL ALBINO RATS IN THE PRESENT WORK

<table>
<thead>
<tr>
<th>In Respect Of</th>
<th>Length: Average</th>
<th>Breadth: Average</th>
<th>Dorsal: Average</th>
<th>Ventral: Average</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range in cm.</td>
<td>Range in cm.</td>
<td>Range in cm.</td>
<td>Range in cm.</td>
<td>Range in cm.</td>
</tr>
<tr>
<td>(A) Different Types of &quot;Control&quot; Testes</td>
<td>1.700 to 1.944</td>
<td>0.600 to 1.032</td>
<td>0.750 to 1.169</td>
<td>1.000 to 1.291</td>
<td>1.000 to 1.121</td>
</tr>
<tr>
<td>(B) &quot;Vasectomised&quot; Testes</td>
<td>1.700 to 2.034</td>
<td>0.700 to 1.088</td>
<td>0.820 to 1.190</td>
<td>1.004 to 1.299</td>
<td>1.004 to 1.139</td>
</tr>
</tbody>
</table>
### PART II: TABLE NO. 9

**TABLE SHOWING THE AVERAGE WEIGHT OF TESTIS AND EPIDIDYMIS, AND THE AVERAGE RELATIVE WEIGHT OF THE LATTER IN PROPORTION TO THE WEIGHT OF THE FORMER, IN DIFFERENT TYPES OF "CONTROL" AND "VASECTOMISED" TESTES IN EXPERIMENTAL ALBINO RATS IN THE PRESENT WORK**

<table>
<thead>
<tr>
<th>IN RESPECT OF</th>
<th>RANGE OF AVERAGE RANGE OF AVERAGE AVERAGE RELATIVE</th>
<th>AVERAGE</th>
<th>RANGE OF AVERAGE RANGE OF AVERAGE AVERAGE RELATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TESTIS WT. OF EPIDIDYMIS WT. OF EPIDIDYMIS</td>
<td>TESTIS WT. IN EPIDIDYMIS WT. IN EPIDIDYMIS</td>
<td>WT. IN PROPORTION TO TESTIS WT.</td>
</tr>
<tr>
<td></td>
<td>GRMS.</td>
<td>GRMS.</td>
<td>GRMS.</td>
</tr>
<tr>
<td>(A) DIFFERENT TYPES OF &quot;CONTROL&quot; TESTES</td>
<td>0.800 to 1.570</td>
<td>0.300 to 0.465</td>
<td>0.388 1 in 3.157 part of testis wt.</td>
</tr>
<tr>
<td>&quot;VASECTOMISED&quot; TESTES</td>
<td>0.820 to 1.560</td>
<td>0.350 to 0.960</td>
<td>0.655 &quot; 1.928 &quot;</td>
</tr>
</tbody>
</table>
**PART II : TABLE NO. 10**


<table>
<thead>
<tr>
<th>IN RESPECT OF SEMINIFEROUS TUBULES</th>
<th>NO. OF TUBULES IN EQUATOR OF ONE FIELD</th>
<th>TUNICA ALBUGINEA RANGE AVERAGE DIAMETER IN MICRON</th>
<th>TUNICA PROPRIA ET BASEMENT MEMBRANE RANGE AVERAGE THICKNESS IN MICRON</th>
<th>WIDTH OF INTERTUBULAR SPACE RANGE AVERAGE WIDTH IN MICRON</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANGE OF AVERAGE DIAMETER IN MICRON</td>
<td>DIAMETER IN MICRON</td>
<td>RANGE OF AVERAGE OF NUMBER</td>
<td>RATIO AVERAGE</td>
<td>THICKNESS IN MICRON</td>
</tr>
<tr>
<td>DIFFERENT TYPES OF &quot;CONTROL&quot; TESTES</td>
<td>87.00 to 183.00</td>
<td>6.00 to 6.72</td>
<td>15.00 to 91.50</td>
<td>0.80 to 2.50</td>
</tr>
<tr>
<td>&quot;VASECTOMISED&quot; TESTES</td>
<td>345.00 to 382.60</td>
<td>8.00 to 8.34</td>
<td>345.00 to 382.50</td>
<td>8.34 to 382.50</td>
</tr>
</tbody>
</table>
PART II

GRAPHS
PART II - Graph 1

Column Graph showing average Relative Weight of Testis per unit of average Weight of Epididymis in Experimental Albino rats.

'A' Individual. 'B' Grand average of 'A'.

N.B. - 'V' = Vasectomised; 'M' = Control with 'Mock' operation; 'U' = Control without 'Mock' operation; 'C' = Ordinary Control without 'Mock' operation.

Points in Abscissa Represent one unit of Epididymis, and points in ordinate represent corresponding weight of testis.

PART II - Graph 2

Column Graph showing average Diameter of Seminiferous Tubules, Thickness of Tunica Albuginea and of Tunica Propria Et Basement Membrane, and Width of Intertubular space of Testis in Experimental Albino rats in Micron.

N.B. - 'V' = Vasectomized; 'M' = Control with Mock operation; 'U' = Control without Mock operation:
PART II
CHAPTER V
DISCUSSIONS AND CONCLUSIONS
DISCUSSIONS
GROSS ANATOMY

In the experimental albino rats, the weight and dimensions of the testes as well as the specific gravity of testicular tissue in both vasectomised and control sides have been detailed in Tables 1 - 8.

An analysis of the data detailed in Tables 1, 2, 7 reveals that the average weight of the testes on the vasectomised sides (1.263 grms.) is greater than that of the control sides (1.225 grms.). This however does not take into account the unusual cases, specimens 12\textsuperscript{a} and its counterpart 12\textsuperscript{c}, 14\textsuperscript{a}, 9\textsuperscript{a}, 13\textsuperscript{a}, and 5\textsuperscript{a} in which abnormalities were glaring in the form of either unusual enlargement or degeneration of the testis.

The analysis of the data on dimensions as well as specific gravity of testicular tissue detailed in Tables 3, 4, 8 shows that the average length, breadth and dorso-ventral diameters of the testes as well as the specific gravity of the testicular tissue in the vasectomised sides are also greater than those of the control sides.

It will be seen that the present findings regarding enlargement of vasectomised testes agree only with those of Cooper (1823, quoted by Cooper, 1845) who mentions that the
testis becomes somewhat enlarged as an effect of vasectomy, but fails to do so with those of Gosselin (1853) and Curling (1866) who mention that 'the vasectomised testis is normal or it undergoes no changes'. Other earlier workers referred to in the review of literature, who performed experimental vasectomy and observed degeneration in the testis as a result of vasectomy, are seen to be silent as regards the weight and dimensions of the testis.

Strikingly enormous and unusual enlargement of one or both the testes in specimens $14^\text{V}$, $9^\text{V}$ and $13^\text{V}$ (Tables 1, 2 & figs. 1, 2) has been found. It is to be noted specially that this is not real enlargement but a pseudo-hypertrophic enlargement. This pseudo-hypertrophic enlargement is produced by the accumulation of exudates in the intertubular spaces and at times extending into the zone beneath the tunica albuginea without any real hypertrophy of the parenchymatous or interstitial tissue of the organ itself. No earlier workers have mentioned about this pseudo-hypertrophic enlargement.

The vasectomised left testes of the specimens $12^\text{V}$ and $5^\text{V}$ were found, after operation was done in the scrotum, to have gone up in the abdominal cavity and appeared quite small in size and almost completely degenerated. These testes were minimum in dimensions (Table 4) and lost weight markedly (Table 2). Oslund (1923-1924) and Moore (1924) mention that
following vasectomy the testis-scrotal relationship may be altered, that is the testis may occupy the abdominal cavity leaving its normal position in the scrotum, and the testis degenerates under such circumstances. They do not, however, mention anything about the size and weight of testis in these cases.

It has been observed that the epididymides of the testes that were found in the abdominal cavity, were also considerably reduced in weight (Table 6). This fact concerning the epididymis has not been noted by any earlier worker.

In the present study, the weight of the epididymis in the vasectomised testis (except those which occupied the abdominal cavity) was found greatly increased (Tables 6, 9) compared with that in control testis (Tables 5, 9). This fact is also represented in Graph 1. The average weight of the epididymides on the vasectomised sides has been found to be 0.655 grm. in contrast to that of 0.388 grm. on the control sides. It would be seen, therefore, that the average weight of the epididymis on the vasectomised sides is increased 1.688 times the average weight on the control sides. Hence, the present findings tend to fall in line with the observations of Curling (1866), Brissaud (1880), Tournade (1903), Spangaro (1903, 1904), Shatton and Seligman (1904), Wallace (1905), Oslund (1924a), Nonidez (1924), Warwick (1925) and
Humphrey (1926) who mention that 'epididymis in the vasectomised side is greatly distended or enlarged'. None of these workers however recorded any observation regarding the amount of enlargement or change in the weight of epididymis in the vasectomised side but simply mentioned that the epididymis in the vasectomised side is distended or enlarged.

In the present study, spermacyst has been found formed in the head of the left epididymis on vasectomised side in specimen 4 (fig. 3) and in the testicular end of the resected left vas deferens in specimen 2 (fig. 4). It is, therefore, seen that the testicular end of the resected vas deferens is not the only site where spermacyst can be formed, but it may as well be formed at the head of the epididymis.

The present observations corroborate those of Tournade (1903) and Sand (1921, 1923) who mention that spermacyst sometimes develop at the testicular end of the resected vas deferens. None of them, however, points out that spermacysts may also be developed within the head of the epididymis on the vasectomised side. Tiedje (1921) mentions about the formation of spermatocele or sperm-vesicle but does not mention where it is actually formed.

DEGENERATIVE CHANGES OR ABSENCE OF THE SAME

In the present study on experimental vasectomy in albino
rats, it has been observed that the testes reacted or behaved differently even under similar conditions of experimental operations, environments and food. Wide range of variations that has been observed in the present study with regard to the effects of vasectomy on the testis provides the reasons why earlier workers raised highly controversial issues concerning the effect of vasectomy on the testis.

It is known that aspermatic condition of the testis or inhibition of sperm production or degeneration of the seminiferous epithelium or changes in the testis closely resembling those in cryptorchidism, depend on various factors, such as: (i) pneumonia, inflammation, mumps, exclusive meat diet or high protein diet, obesity, alcoholism, influenza, tuberculosis, circulating toxins, venereal diseases, deficiency in vitamins B, C and E, exposure to X-ray and radium, intake of nicotine and thyroid extract, injury to tuber cinereum and anterior lobe of pituitary gland or hypophyseal abnormality (Oslund, 1923-24, Moore, 1926; Rasmussen, 1928); (ii) elimination of sympathetic nervous system that results in nutritional disturbances due to paralysis of blood vessels (Kuntz, 1919b); (iii) experimental ligation of the spermatic vessels (Griffiths, 1896; Wangenstein, 1927); (iv) experimental replacement of the testis within the abdominal cavity (Griffiths, 1893); (v) rise of temperature, local or general (Crey, 1921-1922; Fukui, 1923; Oslund, 1923-24); (vi) toxins, genetic constitution, vascular
conditions and the autonomic nervous system as in anxiety states (Engle, 1952); and (vii) denervation of the lumbar spinal nerves which probably pass through the sympathetic trunk (Brown, 1956).

In the present study, it has been observed that the degenerative changes in the seminiferous epithelium of the vasectomised testes in specimen 10V started as early as 54th day, but on the other hand no such degenerative changes were evident in the vasectomised testes in specimen 2V even as late as 276th day.

VASECTOMY WITH CONTRALATERAL TESTIS UNTOUCHED

Under the above series of four experimental albino rats, in specimens 18U, 15V, 3U and 1V, unilateral vasectomy operations were performed with the contralateral testes kept untouched for control observations thereon. The animals were later sacrificed after 7, 78, 224 and 298 days respectively. Both the testes in specimen 18U, sacrificed after 7 days, were found to be normal with no degenerative changes in them. The vasectomised left testis in specimen 15V, sacrificed after 78 days, showed partial degeneration (fig. 6). The right testis in this specimen was, however, found to be normal (fig. 5) in consideration of the criteria mentioned in Page 404, Para 2. The vasectomised right testes in specimens 3U and 1U, sacrificed after 224 and 298 days respectively following
operation, showed considerable degenerative changes in the seminiferous epithelium (fig. 7), but the contralateral testes that were not interfered with in any way, had also undergone some degree of degenerative changes (fig. 8). In every specimen in this series, however, both the testes except the vasectomised right testis in specimen 17^V, revealed evidences of active spermatogenesis with production of spermatozoa, of course, in varying degrees in varying number of tubules. Uniform or constant results were, therefore, not found in the testes of the above series of specimens though the types of experimental operations were all similar.

**UNILATERAL VASECTOMY WITH 'MOCK' OPERATION ON CONTRALATERAL SIDE**

Under the above series of ten experimental albino rats, in specimens 17^V, 16^V, 14^V, 9^V, 13^V, 8^V, 7^V, 6^V, 5^V and 4^V, unilateral vasectomy operations were performed with 'Mock' operations on the opposite sides for control observations thereon. The animals were sacrificed after 14, 33, 97, 99, 112, 127, 134, 143, 200 and 259 days respectively. Both the testes in specimens 17^V, 16^V, 8^V, 7^V, 4^V including only the right testis in specimen 5^V were found to be normal showing active spermatogenesis with production of spermatozoa and without evidence of degenerative changes in the seminiferous epithelium (figs. 13, 14, 15).
Both the testes in specimens 14 and 13 had undergone degenerative changes which were more marked however in the vasectomised organ, and had accumulation of appreciable amount of exudate in the intertubular spaces (figs. 11, 12). The accumulation of exudate was, however, extensive in the left testis of specimens 14.

Both the testes in specimen 9 had undergone degenerative changes with associated fibrosis and narrowing of the tubules but the fibrotic changes were more evident in the right control testis (figs. 9, 10).

No such accumulation of exudate was found in either testis in specimen 6. Both the testes in this specimen appeared almost normal and very slight degenerative changes in them were evident.

The vasectomised left testis in specimen 5 that occupied the abdominal cavity instead of the scrotum following the operation, was found to have undergone complete degeneration associated with fibrosis (fig. 16). Obviously, it remains unaccountable how far the degenerative changes are due to the effect of vasectomy itself and how far they are due to abdominal position of the testis.

No uniform or constant results were, therefore, found in the above series of specimens though the types of experimental operations were all similar.
BILATERAL VASECTOMY WITH CONTROL FROM SEPARATE ANIMALS

Under the above series of eight experimental albino rats, in specimens 10\textsuperscript{V}, 12\textsuperscript{V}, 11\textsuperscript{V} and 2\textsuperscript{V}, bilateral vasectomy operations were performed and separate animals, specimens 10\textsuperscript{C}, 12\textsuperscript{C}, 11\textsuperscript{C}, and 2\textsuperscript{C} of the same litre and naturally of the same age and approximately of the same weight had been kept for use as control. The animals were sacrificed after 54, 74, 118 and 276 days respectively. It was found that both the testes in specimen 10\textsuperscript{V}, had undergone partial degeneration and had accumulation of slight amount of exudates. In specimen 12\textsuperscript{V}, the left testis and epididymis that were found occupying the abdominal cavity, were almost completely degenerated and atrophied associated with fibrosis, but the right testis in this specimen, however, had undergone very slight degeneration with accumulation of slight amount of exudates. Both the testes in specimen 11\textsuperscript{V} revealed degenerative changes only scarcely (figs. 17, 18). It may be recalled here as mentioned before that a spermacyst was found developed in the head of the left epididymis in this specimen. Both the testes in specimen 2\textsuperscript{V} were found to be normal with spermatogenesis going on actively and without degenerative changes in the seminiferous epithelium that maintained stratified arrangement of the spermatogenic cells (figs. 19, 20). But as mentioned before a spermacyst was found developed appreciably proximal to the
testicular end of the resected vas deferens on the left side. Both the testes in specimens 10VC, 12VC, 11VC and 2VC that were used as control animals were, however, found normal in every respect.

Herein also uniformity and constancy in the results following vasectomy in the testes of the above series of specimens, were absent though the types of experimental operations were all similar.

**ANALYSIS OF THE RESULTS**

A critical analysis of the effects of vasectomy on the testes under the different series of experimental albino rats already noted above reveals the following:

Both the testes, vasectomised or control in specimens 18V, 17V, 16V, 8V, 7V, 4V, 2V, 10VC, 12VC, 11VC and 2VC, sacrificed between 7 to 276 days following vasectomy, were found to be normal without degenerative changes in the seminiferous epithelium. In these testes there was active spermatogenesis with the production of plenty of spermatozoa that were found not only within the seminiferous tubules but also in the sections of epididymides occupying the lumina of vasa efferentia (figs. 22, 23) and epididymal canal. The only changes
found in the vasectomised testes of these specimens as observed by micrometry were but slight increase in diameters of the seminiferous tubules, in thickness of the basement membrane et tunica propria as well as of the tunica albuginea and in width of the intertubular spaces. These appear to be the common effects of vasectomy. These changes, however, do not affect in any way the process of normal spermatogenesis.

However, either one or both testes, vasectomised or control in specimens 10\textsuperscript{V}, 12\textsuperscript{V}, 15\textsuperscript{U}, 14\textsuperscript{V}, 9\textsuperscript{M}, 13\textsuperscript{M}, 11\textsuperscript{V}, 6\textsuperscript{M}, 5\textsuperscript{M}, 3\textsuperscript{V} and 1\textsuperscript{V}, sacrificed between 54 to 298 days following vasectomy, were found to be abnormal and showing varying degrees of degenerative changes.

It is seen that 'simple obstruction caused by ligation and resection of the vas deferens does not always bring about degenerative changes in the vasectomised testis'. Other factors obviously play a part to account for the structural changes in the testis. This becomes all the more evident since in some cases the control testes, such as in specimens 1\textsuperscript{V} and 3\textsuperscript{V} where no vasectomy had been done, were also found to have undergone degeneration in varying degrees. No degenerative changes, however, were observed in similarly unoperated control testes in specimens 18\textsuperscript{V} and 15\textsuperscript{V}.

The present observations thus agree only in respect of
specimens $1^V$ and $3^V$ with those of Kuntz (1919b, 1921) who found
degeneration of varying degrees of seminiferous epithelium on
the unoperated side synchronously with those in the testes
where the ductus deferens was occluded by vasectomy and ligation,
and mentioned that 'these degenerative changes are, doubtless,
associated with and conditioned by the degeneration of the
testes of the operated side and are probably an expression of
the physiological state of the experimental animal'.

Furthermore, in the present study, specimens $14^V$, $9^V$, $13^V$ and $6^V$ in which unilateral vasectomy with "Mock" operations
on the opposite sides were performed, revealed degenerative
changes in the seminal epithelium of the testes of the control (Mock) sides.

In these above instances only, the suggestion by Kuntz
(1919b) that sectioning of sympathetic plexus that results in
nutritional disturbances due to paralysis of the blood-vessels
in the spermatic cord and testis, might be considered rational
and responsible for degeneration of the testis.

Hence, the observation of the present study in the above
cases in particular, practically agree with those of Kuntz
(1919b) and Brown (1956) who generally agree that elimination
of the sympathetic nerve supply to the testis is followed by
degeneration of the seminal epithelium.
The role played by the sympathetic nerve supply to the testis offers more than a plausible explanation as advanced by Kuntz (1919b) in view of the description of the testicular (external spermatic) plexus with its formation and distribution as mentioned by Kuntz (1919a), Hamilton (1958), Davies and Davies (1962) and Copenhaver (1964) who generally agree that testicular (external spermatic) nerves or testicular plexus of nerves contain both efferent and afferent sympathetic fibres and accompany the spermatic or testicular arteries distally and enter the gland with either the blood vessels or efferent ducts. The terminal distribution of the testicular nerves is not confined alone to blood vessels of the testis proper but also supply the smooth muscle in the wall of the epididymal ducts and canal (vasa efferentia and epididymal canal). The efferent sympathetic fibres are vasomotor in nature; the parasympathetic fibres which are supposed to be derived from the inferior hypogastric plexus and supplying the testis, are probably vasodilator in nature. Further, it is interesting to note that Letzerich quoted by Turner (1877) mentions that nerve fibres pierce the proper wall of the seminiferous tubules, and end in clumps of protoplasm, having a direct relation to the sperm cells.

In view of the above description concerning the distribution of the testicular nerves especially their close relation
to the vascular supply, it is more than probable that an interference with these nerves might react on the tissue of the organ secondarily by affecting the blood vessels primarily.

It is, however, to be noted that the 'Control' testes in specimens 17\textsuperscript{V}, 16\textsuperscript{M}, 8\textsuperscript{M}, 7\textsuperscript{M}, 5\textsuperscript{M} and 4\textsuperscript{M} in which the same 'Mock' operations were performed, did not show similar degenerative changes in the seminiferous epithelium. How could then the organ escape unaffected? becomes a ticklish question. Does it depend on the degree or extent of the damage done by such operative interference?

As mentioned before, it has been observed in the present study that the vasectomised left testes had developed spermacyst at the testicular end of the resected vas deferens in specimen 2\textsuperscript{V} (fig. 4) and at the head of epididymis in specimen 11\textsuperscript{V} (fig. 3). The left testes in the specimen 2\textsuperscript{V} remained normal and had active spermatogenesis (fig. 20), but the left testis in the specimen 11\textsuperscript{V} showed partial degeneration of the seminiferous epithelium (fig. 18).

It is obvious, therefore, that formation of spermacyst is not always sufficient for the prevention of degeneration of the seminiferous epithelium. In this respect the present observations are in full accord with those of Tournade (1903) who mentions that 'the pressure on the seminiferous epithelium...
is diminished by the formation of the cyst which should be necessary, although sometimes insufficient, to keep it intact'.

It might be likely that this spermacyst formation would relieve to a great extent, the extra-brunt of pressure load inside the seminiferous tubules particularly acting as an extra-reservoir and thereby maintain the integrity of the seminiferous epithelium by establishing an equilibrium between the rate of production of spermatozoa inside the seminiferous tubules, and rate of absorption of disintegrated spermatozoa through the epididymis. The above contention holds good only for those vasectomised testes which did not undergo any degeneration following the formation of spermacyst and not for those which degenerated in spite of the formation of spermacyst.

As regards the mechanism of formation of spermacyst it may be rationally suggested that when the epididymis fails to further distend uniformly to make room for the accommodation of the continuously produced spermatozoa, a cyst is formed at the testicular end of the resected and ligated vas deferens or at the head of the epididymis provided there is some structural weakness in the wall of the vasa efferentia or epididymal canal or vas deferens.

In those cases where spermacyst formation is in demand but cannot be formed probably due to the existence of better integrity of the wall of excretory canals, the testis itself
or the simple distension of the epididymis may fail to stand the whole brunt of back pressure. The exudates with debris produced by the destruction of spermatogenic cells and the spermatozoa, after filling up the lumina of the seminiferous tubules, may enter into the intertubular spaces and at times even into the spaces beneath the tunica albuginea and form what has been already designated as 'pseudo-hypertrophic enlargement' of the testis.

In the present study the epididymis has been found invariably always enlarged as a result of vasectomy and yet the testis has undergone degeneration and atrophy in many cases. Particularly in these instances, a proper equilibrium between the rate of production of spermatozoa and the rate of their removal subsequent to destruction might not have been established. It seems relevant here to cite Oslund (1924a) who mentions that "following vasectomy, the epididymis is usually distended and hardened by the accumulation in it of testicular products, and an equilibrium is quickly reached between rate of production of testicular material and its absorption from the epididymis, and the establishment of such an equilibrium is a factor in preventing pressure atrophy in the seminiferous tubules."

As mentioned before, it was observed that in specimens 12^V and 5^V, the vasectomised left testes which were found occupying the abdominal cavity and adherent to the surrounding
peritoneum, got degenerated (fig. 16). These observations thus corroborate fully those of Oslund (1923-24) and Moore (1924) who mention that when degeneration of the testes occurred following vasectomy, it was due to the fact that the testes occupied the abdominal cavity or the testis-scrotal relationship did alter following the operation. At the same time it was found in the present study that the rest of the testes that were found inside the scrotum following vasectomy did not all remain normal, but some amongst them underwent degeneration as well.

Hence, the observations in the present study appear to be in accord only in part with those of Fukui (1923), Oslund (1923-24), Moore (1924), and Moore (1926) who agree that an animal can be become sterile by its own body heat when the testis-scrotal relationship is abnormal or in other words, the degeneration of the testis occurs when it occupies the abdominal cavity and no degeneration takes place when it remains in the scrotum following vasectomy. It may be noted here that according to Benedict and Slack, 1902 quoted by Oslund, 1923-24, there is a temperature gradient of about 5°C between the body cavity and that of the surface of the body.

Bouin et Ancel (1903, 1904), Ancel and Bouin (1923), Richon and Jeandelize (1903), Myers (1915), Massaglia (1920), Steinach (1921, quoted by Moore, 1926), Kuntz (1921), Wheelon
(1921), Tiedje (1921), Sand (1921), Wagenen (1925), Sharpey-Schäfer (1926) and Bell et al (1963) generally agree that degeneration of the testis occurs as an effect of experimental vasectomy. Tiedje (1921) and Steinach (1920, quoted by Moore, 1926), however, mention that degeneration is followed by regeneration, but according to Moore (1926) neither of the above two workers could give substantial evidence in support of their contentions.

On the other hand, Turin (1786), Hunter (1841), Gosselin (1847), Curling (1866), Simmonds (1898) and Brack (1921) basing on their study of human subjects during dissection or autopsy, conclude that complete stenosis or obstruction of the vas deferens does not involve any degeneration of the testicle. Gosselin (1847) in particular draws the following principal conclusions; (1) the testicles, of which the sperm cannot reach seminal vesicles, do not become atrophied; (2) the testicles deprived of communication for the excretion of their products, do not produce less of sperm with its physiologic characteristics.

Gosselin (1953), Curling (1866), Guyon (1895), Spangaro (1903, 1904), Wallace (1904, 1905), Shattock and Seligman (1904) studied the results of vasectomy in the testes of different animals (including human subjects vasectomised by Spangaro), concluded that no degeneration of the testis occurs and spermatogenesis remains unaffected by vasectomy.
Tournade (1903), Kuntz (1921), Oslund (1923-24; 1924a, b), Moore and Oslund (1923-24), Moore (1924, 1926), Warwick (1925) and Humphrey (1926) however mention that degeneration of testis or retention of its normal condition depends on different factors or circumstances. Some of these workers, such as Oslund (1923-24), Moore and Oslund (1923-24), Warwick (1925) and Humphrey (1926) do make a bold statement that vasectomy by itself does not cause degeneration of the testis, and when degeneration occurs it is absolutely due to causes other than vasectomy.

The observations in the present study agree in many respects with those of the last group of workers, as vasectomised testes in some cases are found to have undergone degeneration while in some other cases they did retain normal character. The reasons or explanations put forward in this regard by earlier workers appear to be speculative.

It is known that complete or even intermittent ligation of the bile duct or pancreatic duct or ureter invariably bring about pathological changes leading finally to degeneration and fibrosis of the organ concerned. It may further be pointed out that according to Brissaud (1880) his master, Charcot first experimentally produced visceral cirrhosis by ligation of the excretory canals of the glands.
Why then the testis in particular should behave differently and should enjoy a special prerogative in this respect appears to be a ticklish question which has not yet been answered satisfactorily.

Simeone and Young (1931), and as cited by them, — Regaud and Tournade (1911), Marshall (1922) and Priesel (1924) mention that the epididymis can act not only as a reservoir for non-ejaculated spermatozoa but also as a site for quick absorption of the products of blocked-up, stagnated and disintegrated spermatozoa. Moreover, spermacyst that might be developed at the proximal end of the resected vas deferens (Tournade, 1903; Sand, 1921, 1923), and also at the head of the epididymis in addition to that at the proximal end of resected vas deferens as observed in the present study, may act as an emergency accommodation for further amount of spermatozoa and relieve tension or back-pressure inside the seminiferous tubules, so that degeneration of the seminiferous epithelium gets obviated and spermatogenesis goes on normally as a result.

The present study points towards the possibility of the testis for not undergoing parenchymatous alteration in all cases as being due to its structural peculiarities. Unlike glands in general, the testis is a delicate soft organ having
its interstitial tissue remarkably loose. The delicate basement membrane et tunica propria constitute a lamellar structure composed of fibro-elastic tissue in which are present a few reticular fibres. The lamellae are separated by interlamellar spaces (Burgos, 1959-60, PART I). The walls of the tubules have minute canals (Plato, 1897, quoted by Whitehead, 1908, PART I). The character and disposition of the concentric lamellae, having minute spaces in between the fibrils are revealed by Reticulin and Weigert's staining in this study (PART I). All these point to the possibility of exudates, the products of destruction of blocked-up spermatozoa and their debris to come out under excessive pressure or tension from inside the seminiferous tubules into the intertubular spaces. This appears to relieve tension inside the tubules and ensure a balance or equilibrium between the rate of formation and the rate of absorption of exudates. Seminiferous epithelium is thus saved from pressure atrophy and spermatogenesis therefore goes on unhindered. But if the equilibrium is lost, the exudates that come out of the tubules and fill up the intertubular space may remain blocked up and stagnated due to failure of the blood vessels to remove them by absorption. As a result, the seminal epithelium might become subjected to pressure both from within and outside. This probably causes varying degrees of degeneration or atrophy of the seminiferous epithelium and in some instances may lead to complete fibrosis of the tubules and atrophy of the gland as a whole.
In fact, in a number of instances in the present study, it is seen that the vasectomised testes turned abnormal and the seminiferous epithelium did degenerate and in some cases got completely atrophied. Was it only because of the possibility of the rate of absorption of the disintegrated spermatozoa through the epididymis failing to keep pace with the rate of formation of the spermatozoa resulting in a failure of equilibrium between the two processes?

Apart from all that have been mentioned in this connection, it is questionable whether histamine-like substances are liberated at the site of surgical trauma which might have deleterious effect on the endothelial lining of the blood vessels. The damaged endothelium due to histamine effect might produce increased permeability of vascular walls which leads to accumulation of exudates in the intertubular spaces causing pressure on the tubular walls and indirectly affects the nutrition of the tubular epithelium. Solution of the above problem is beyond the scope of the present study and the same may be kept open for future workers to solve it.

There is no gainsaying of the fact that there is accumulation of fluid exudates in the intertubular spaces as well as in the subalbugineac region in many instances in vasectomised testis. In the experimental animals, the question of vitamin deficiency or nutritional deficiency cannot arise as all the
animals were given the same and sufficient balanced diet and maintained under the same environmental conditions. Why should then be any difference in the effects of vasectomy?

In the present study, interstitial cells in the intertubular tissue have not been found visibly increased or changed in character in vasectomised testes irrespective of degeneration or absence of it in them; so they cannot be considered to have undergone hyperplasia or hypertrophy as an effect of vasectomy. Thus the observations in the present study are in full accord with those of Myers (1915), Tiedje (1921), Retterer and Voronoff (1923), Moore and Oslund (1923-24), Oslund (1924a), Moore (1924) and Humphrey (1926) who maintain that no hypertrophy or hyperplasia of the interstitial cells follows vasectomy. The present observations, however, fail to agree with Bouin and Ancel (1903, 1904), Kuntz (1919b), Sand (1921) and Steinach (1910-1920, quoted by Moore, 1926, Benjamin, 1922 and Oslund, 1924b) who mention that there is hypertrophy or hyperplasia of the interstitial cells as a result of vasectomy.

MICROMETRY

In the present study, micrometry was done only in the typical cases of experimental vasectomy in which the testes did not undergo any significant degenerative changes following vasectomy.
The average thickness of tunica albuginea in the vasectomised side has been found to be 109.50 μ and in the control side 91.50 μ. Appreciable difference is revealed, therefore, in the thickness of tunica albuginea in vasectomised and control sides (Table 10 & Graph 2).

The average diameter of the seminiferous tubules in the vasectomised side has been found to be 193.35 μ and in the control side 183.00 μ. Therefore, a significant increase has been found in the average diameter of the seminiferous tubules in the vasectomised testes compared to that in the control testes (Table 10 & Graph 2).

In this respect the observation in the present study is in accord with those of Retterer and Voronoff (1923) who mention that the seminiferous tubules are considerably dilated following vasectomy but not with those of Bouin and Ancel (1903) who mention that the diameters of the seminiferous tubules are reduced following vasectomy. Brissaud (1880) mention, however, that the tubules get dilated between 5 to 10 days following vasectomy but are narrowed in the long time.

In no case, has there been found any decrease in the average diameter of seminiferous tubule, except where the degenerative process has progressed to the stage of fibrosis. In none of the present cases, however, has there been observed any rupture of seminiferous tubules and entry of spermatozoa
into the intertubular spaces and formation of granulation tissue though Nonidez (1924) mentions that such events do occur occasionally.

In the vasectomised side under the same low power microscope, the average number of cross-sections of the seminiferous tubules lying on the equatorial line of one field has been found to be less (6.33) than that in the control sides (6.72) indicating thereby an increase in the diameter of the seminiferous tubules as a result of vasectomy (Table 10). This simple and easy method of counting the cross-sections of the seminiferous tubules lying on the equator of one field is of great help in deciding the question of inter-relationship in size between the seminiferous tubules and intertubular spaces as a result of vasectomy. The proper assessment of the condition in the vasectomised testis in respect of the above has been made by micrometric measurements.

In the vasectomised testes, the average thickness of the basement membrane et tunica propria has been found to be 3.09 u and in the control side 2.50 u. Hence, there is appreciable increase in the thickness of basement membrane et tunica propria in vasectomised testes (Table 10 & Graph 2). This fact corroborates the observations of Retterer and Voronoff (1923) who mention that such increase in thickness does happen.
In the vasectomised testes, the average width of the intertubular spaces has been found to be 145.80 u and in the control testes 139.50 u (Table 10 & Graph 2). Hence, there is appreciable increase in the intertubular spaces in the vasectomised testes, but this increase is not associated with hypertrophy or hyperplasia of the interstitial cells.
SUMMARY AND CONCLUSIONS

The present experimental study in albino rats attempts at explaining some problems that confronted earlier workers concerning the effects of experimental vasectomy on different animals.

1. The absolute weight of the testis and its relative weight in proportion to body weight including the dimensions of the testis in both vasectomised and control sides have been found out for the first time in order to determine whether there is actually any change in size and weight of the testis as a result of vasectomy.

2. The testis of the vasectomised side has been found in general to be slightly enlarged than that of the control side.

3. In unusual cases, the phenomenon of pseudo-hypertrophic enlargement of the testis in both vasectomised and control sides, has been found and noted for the first time.

4. The absolute weight of the epididymis and its relative weight in proportion to the weight of the testis in both vasectomised and control sides, have been calculated for the first time in order to determine the actual increase in weight of the epididymis after vasectomy compared to that of the control side.

5. A marked increase in the weight of the epididymis of the vasectomised side has generally been found. This is seen to
be on an average 1.612 times greater than that on the control side.

6. The effects of experimental vasectomy on testes of albino rats have been found to be not uniform and constant. The testes react differently under different circumstances as a result of this operation in albino rats.

7. It has been found that degeneration of the testis does not occur ordinarily as an effect of vasectomy, and the process of spermatogenesis is not affected in all cases except in a few where spermatogenesis is affected adversely. Vasectomy therefore does not stop the process of spermatogenesis as a normal course, except under certain conditions where it is adversely affected.

8. There do occur 'sympathetic' changes in some cases in the control testis with or without 'Mock' operation. The reasons remain unexplained.

9. Micrometric measurements have been done to determine the actual differences in the thickness of tunica albuginea, basement membrane et tunica propria, diameters of seminiferous tubules and width of intertubular spaces in vasectomised and control testes for the first time. It has been observed, however, that the mean averages of all these measurements are appreciably increased in vasectomised testes compared to those in control testes.
10. The findings of the present study with regard to experimental vasectomy would appear to remain speculative and fairly far from warranting any dogmatic deductions. It would therefore be injudicious and unjustifiable 'to take sides' with any particular school of thought of earlier workers in this regard concerning 'degeneration' or absence of the same as a result of vasectomy. But it may be claimed that the studies undertaken in the present work would throw some interesting light with regard to certain structural modifications caused by the experimental operations and would, therefore, be helpful for further work on the line, the results of which might be of applied importance in the field of work related to the problem of 'over-population' that appears to be a socio-economic menace in the world today.
PART II
CHAPTER VI
PHOTOGRAPHS AND MICROPHOTOGRAPHS
Photograph of experimental Albino rat testes in situ, Sp. 94-99 days following unilateral vasectomy \( V \) on left side with "Nock" operation on contralateral side. Ventral view.

**Fig. 1**

Site of resection of vas deferens.
- Rt. corpus adiposum - normal in size.
- Lt. corpus adiposum - reduced in size.
- Lt. testis - abnormally enlarged due to accumulation of fluid exudates beneath the tunica albuginea (pseudo-hypertrophic enlargement).
- Rt. testis - similarly enlarged but to a little less extent.
- Lt. epididymis, especially its tail appreciably enlarged.

**Fig. 2**

Photograph of experimental Albino rat testes in situ, Sp. 134-112 days following unilateral vasectomy \( V \) on left side with "Nock" operation on contralateral side. Ventral view.

Site of resection of vas deferens.
- Rt. corpus adiposum - normal in size.
- Lt. corpus adiposum - slightly reduced in size.
- Both testes enlarged with accumulation of fluid exudates beneath the tunica albuginea (pseudo-hypertrophic enlargement) but left testis to a little less extent.
- Left epididymis as a whole enlarged though its tail remains obscured in the photo.

Cotton pad.
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**Fig. 3**

Photograph of experimental Albino rat testes in situ. Sp. 11 1/2 days following bilateral vasaectomy. Ventral view

No pseudo-hypertrophic enlargement in either testis.
Both epididymides enlarged considerably.

Sites of resections and ligations of vasa deferentia.
Spermacyst at head of left epididymis.
Tails of epididymides.
Cotton pad.

**Fig. 4**

Photograph of experimental Albino rat testes in situ. Sp. 21 3/4 days following bilateral vasaectomy. Ventral view

No pseudo-hypertrophic enlargement in either testis.
Both epididymides enlarged considerably.

Sites of resections and ligations of vasa deferentia.
Spermacyst at testicular side of resected left vas deferens appreciably proximal to site of resection.
Cotton pad.
Section of Rt. testis ('Untouched' Control), Sp. 15\% , IH & E x 70x (78 days following unilateral vasectomy)

Section reveals plenty of spermatozoa and no degenerative changes in the seminiferous tubules.

Spermatogenic cells forming thick stratified epithelium.

Plenty of spermatozoa within seminiferous tubules.

Collections of interstitial cells.

Spermatogenic cells though desquamated maintain their normal characteristics individually.

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Section of L.t. testis (vasectomised) Sp. 15\%, IH & E x 70x

Section reveals degenerative changes in a few tubules only.

Considerable exudates in intra- and extratubular regions.

Degenerative changes in germinal epithelium with fibrosis and narrowing of the tubules.

Tubules showing active spermatogenesis with production of abundant spermatozoa.
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**Fig. 9**

*Section of Rt. testis ('Mock' Control), Sp. 9\%, IH & E x 70.*

(99 days following unilateral vasectomy with 'Mock' operation)

Section reveals absolutely abnormal histologic features.

Accumulation of excessive exudates in intertubular space.

Seminiferous tubules - degenerated, narrowed and fibrosed; germinal epithelium practically absent.

Spermatogonia - rare.

Small groups of interstitial cells.

**Fig. 10**

*Section of Lt. testis (vasectomised)*

Sp. 9\%, IH & E x 70.

Section reveals histologic features of both normal and abnormal tubules.

Seminiferous tubules having thick stratified germinal epithelium.

Plenty of spermatozoa forming typical whorls by their tails.

Tubules degenerated, narrowed, fibrosed and practically no spermatogenic cells except spermatogonia present.

Lysis of spermatogenic cells - intensive.
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Fig. 11
Section of Rt. testis ('Mock' Control), Sp. 13W, IH & E x 70 (112 days following unilateral vasectomy with 'Mock' operation)

Section reveals normal histologic features except a few tubules showing abnormalities.

Seminiferous tubule degenerated, narrowed and lined by chiefly spermatogonia.

Spermatogonium with intensely stained round nucleus.

Spermatogonial cells forming thick stratified epithelium with production of abundant spermatozoa.

Collection of interstitial cells.

Fig. 12
Section of Lt. testis (vasectomised)
Sp. 13W, IH & E x 70.

Spermatogenic cells forming quite a thick stratified epithelium - with production of plenty of spermatozoa.

Heavy exudates in intertubular space.

Tubules completely degenerated, narrowed and fibrosed.

Cells desquamated but maintain their normal characteristics individually.
Section reveals characteristic features of a normal testis having, particularly, a well-formed stratified germinal epithelium.

Spermatogenic cells forming thick stratified epithelium.

Collection of interstitial cells in intertubular space.

Plenty of spermatozoa forming whorl by their tails.

Blood vessel.

Section reveals characteristic features of a normal testis as mentioned under Fig. 13.

Spermatogenic cells forming thick stratified epithelium.

Abundant spermatozoa forming typical whorl by their tails.

Considerable exudates accumulated.

Blood vessel - prominent.

Group of interstitial cells.
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Fig. 15
Section of Rt. testis ('Mock' Control). Sp. 55, IH & E x 70. (200 days following unilateral vasectomy with 'Mock' operation).

Section reveals histologic features of a normal testis having, particularly, thick stratified germinal epithelium and plenty of spermatogonia.

Spermatogenic cells forming thick stratified epithelium.

Abundant spermatozoa having their tails typically arranged like whirlpool.

Exudates in intertubular space.

A group of interstitial cells.

Fig. 16
Section of Lt. testis (vasectomised, abdominal. Sp. 55, IH & E x 70.

Section reveals histologic picture of complete degeneration and fibrosis of seminal tubules. Rarely in some tubules only a few spermatogonia and Sertoli cells present; no stratified epithelium nor any spermatozoon visible in any tubule.

Tunica albuginea - thickened.

Seminiferous tubules degenerated, narrowed and fibrosed.

Spermatogonium.

Sertoli cells.

Collection of interstitial cells in intertubular space.
Section reveals histologic features which in general are like those of a normal testis. Degenerative changes with fibrosis rarely visible. Majority of tubules show active spermatogenesis with production of abundant spermatozoa.

Spermatolysis and resorption pari passu intensive spermatogenic activity evident; deeper cells appear to fade and stained less intensely, possibly due to imbibition of fluid exudates.

Tubules degenerated, narrowed and fibrosed.

Thick stratified germinal epithelium.

Spermatozoa.

Strands of interstitial cells.

Section reveals histologic picture practically similar to that mentioned under Fig. 17.

Thick stratified germinal epithelium.

Tubules degenerated, narrowed and fibrosed.

A small group of interstitial cells.

Blood vessel.
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Fig. 19
Section of Rt. testis (vasectomised). Sp. 2 V, IH & E x 70.
(276 days following bilateral vasectomy).

Section reveals histologic features similar to those of a normal testis having active spermatogenesis with production of abundant spermatozoa. No evidence of degeneration present.

Thick stratified germinal epithelium in the seminal tubule.

Tails of spermatozoa forming typical whorls.

Collection of interstitial cells in intertubular space.

Fig. 20
Section of Lt. testis (vasectomised). Sp. 2 V, IH & E x 70.

Section shows normal histologic features similar to those mentioned under Fig. 19.

Thick stratified germinal epithelium.

Tails of spermatozoa arranged in characteristic whirlpool.

Small collection of exudates in intertubular space.

Group of interstitial cells around blood vessel.

Spermatogenic cells desquamated but maintaining their individual normal characteristics.
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Fig. 21
Section of Rt. epididymis ('Mock' Control). Sp. x8, IH & E x 70.
(127 days following unilateral vasectomy with 'Mock' operation).

Microphoto exhibiting characteristic features of normal epididymal cross section.

Collections of spermatozoa within lumen of ductus epididymis (epididymal canal).

Pseudo-stratified columnar ciliated epithelium with stereocilia (brush-like fibrillated ends of cells).

Connective tissue strand separating cross sections of ductus epididymis from those of vasa efferentia.

Collections of spermatozoa within lumina of vasa efferentia.

High columnar ciliated cells (without stereocilia) alternating with cuboidal cells - causing folded or wavy character of inner aspect of the wall (better revealed under high power).

Fig. 22
Section of Lt. epididymis (vasectomised). Sp. x8, IH & E x 70.

Section reveals only cross sections of ductuli efferentes (vasa efferentia) which have become appreciably dilated.

Plenty of spermatozoa undergoing spermatolysis and resorption.

Connective tissue.

Fig. 23
The same section as shown under Fig. 22, under higher magnification. IH & E x 280.

Spermatozoa - enormous.

Wavy character of epithelium (inner lining) practically lost due to increased pressure of accumulated spermia exerting tension upon the wall of ductule.