



HISTOLOGICAL VARIATION OF DIFFERENT SEGMENTS OF FALLOPIAN TUBE IN REPRODUCTIVE WOMEN

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ABSTRACT

Introduction and objectives: Due to increasing rate of infertility, oviducts and their structures gaining importance and have become a major subject of research. The aim is to ascertain any histological variation of different segments of human fallopian tube in reproductive women and the research work could be utilized for investigation and management of infertility.

Material and methods: Fallopian tubes of reproductive women were collected from fresh unembalmed human cadavers received in the department of Anatomy and Forensic Medicine of FAA Medical College, Barpeta, Assam. Specimens were divided into two groups, Group I -18 to 29 years, and Group II - 30 to 41. Fifty specimens were collected from each group. Samples measuring 1.5cm were taken from each segment of the fallopian tube. The slides were prepared using the standard laboratory procedure and under low and high power objectives the whole thickness were observed and epithelial height was measured by using micrometry slides. **Results:** All fallopian tube consists serous layer composed of single layer mesothelial cells and connective tissue. Muscle layer in all the segments consists of outer longitudinal and inner circular layer of smooth muscle cells except intramural segments which contains one additional internal longitudinal muscle layer. In all the tubes intramural segment very low mucosal folds, in isthmus segment only one or two primary mucosal folds and in ampulla arborization of mucosal folds were observed. Epithelium consists of simple columnar type and contains three types of cells, ciliated, secretory & peg cells in all the tubes. Highest epithelial height was recorded in ampullary segment (33.26 μ m and 33.57 μ m) and lowest in intramural segment (28.43 μ , and 28.64 μ m) but no significant difference ($p < 0.01$) between the two groups in the same segment was recorded.

Conclusion: In both the groups Muscle layer is thickest in the intramural segment and thinnest in the infundibular segment and epithelial height was highest in ampullary segment (33.57 μ m).

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INTRODUCTION

The reproduction is directly related to the functioning of the different parts of the genitalia in co-ordination with the other systems of the body. Fallopian tubes are the paired female reproductive organs extending bilaterally from the uterus in the upper margin of the broad ligament of the uterus. Beginning with the ovarian end each tube is divisible into four segments (Fig: 2&3) viz. infundibulum, ampulla, isthmus and intramural or interstitial⁽¹⁾. The infundibulum is funnel shaped and is formed of a number of processes, the fimbriae. Next to the infundibulum, ampulla is the long expanded part which is the normal site of fertilization^(2,3) and terminates in a relatively short firm segment, the isthmus. The intramural part or pars uterine is the medial most part of the uterine tube which is embedded in the wall of the uterus.

Fallopian tube consists of from outside serous layer, muscular layer and mucous layer. Serous layer composed of single layer mesothelial cells and connective tissue. Muscle layer in all the segments consists of outer longitudinal and inner circular layer (Fig:2) of smooth muscle cells except intramural segment. Intramural segment of all the tube contains one additional internal longitudinal muscle layer^(4,5). Inner mucous coat or mucous membrane consists of an epithelium and a lamina propria connected together by a basal lamina. The mucous membrane is thrown into numerous folds obliterating most of the part of the lumen. The folds show branching but there is no anastomosis. The epithelium is of simple columnar type and contains three types of cells. Cells are ciliated, secretory & peg cells (intercalary) cells^(5,6,7). The fallopian tube plays a role in sperm transport and capacitation, ovum/embryo transport, fertilization and early embryogenesis.

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Based on the anatomical observations of Herophilus, in third century B.C., the Alexandrian anatomist, Rufus the Greek anatomist and physician first described the human oviduct as “antennae or octopus like arms extending as prolongation from each side of the uterus”⁽⁸⁾. But till sixteenth century the existence and anatomical relations of the oviducts were not clear. Gabriele Fallopius in his publication of “Observationes Anatomicae”⁽⁹⁾ illustrated the oviducts in a better way, and the term ‘fallopian’ derived from his name. By the mid-nineteenth century, knowledge of the oviduct was relatively complete but contemporary knowledge of the oviduct derives in great part from twentieth century due to advances in technology and application regarding morphological and histological findings. Due to the increasing rate of infertility, the reproductive organs and their functions gaining importance and have become the subject of research in the present era. Studies on fallopian tube in reproductive women have been reported by different workers⁽¹⁰⁾. The present study was carried out to ascertain any histological variation of different segments of human fallopian tube in reproductive women and the research work could be utilized for investigation and management of infertility.

MATERIALS AND METHODS

Specimens were collected from fresh unembalmed human cadavers received within six hours of death in the department of Anatomy, Forensic Medicine and O&G, FAA Medical College, Barpeta, Assam, following all legal formalities and excluding obvious pathological changes. Each specimen was complete with all the segments of the fallopian tube. The specimens of the fallopian tubes were divided into two groups as shown below:

Groups	Ages (Years)	Number of specimens
Group-I (Early reproductive)	18 to 29	50
Group-II (Late reproductive)	30 to 41	50

Fifty specimens (50 tubes) were collected from each group and each tube was complete with intramural, isthmus, ampulla and infundibulum segment (Fig.2 &3). For histological studies four segments of the tubes were identified and from each segment approximately 3 to 5mm pieces were made and fixed in 10% formal saline for 24-48 hours and labeled separately. The fixed tissues were processed for embedding in paraffin and sectioned at 5µm thickness in a ‘Rotary microtome’. Sections were stained with routine Haematoxylin and Eosin method⁽¹¹⁾.

Stained slides were studied under low power objective and different layers of the wall of the fallopian tubes and patterns of the mucosal folds were observed. Different type of cells were observed in both high and low power objectives. Epithelial height was measured with the help of an “Spencer ocular” lens and objective micrometer scale.

Calculation of micrometry scale

15 divisions of ocular micrometer = 5 divisions of objective micrometer.

Therefore, 1 division of ocular scale = 5/15 divisions of objective micrometer.

As 1 division of objective micrometer = 0.01mm

Hence, 5/15 divisions = 5/15 × 0.01mm = 0.003mm = 3.33µm (10⁻³ = 1micron)

Therefore, 1 division of ocular micrometer scale = 3.33µm

Statistical Analysis

The epithelial height of different segments of the fallopian tubes were analyzed by standard statistical methods⁽¹²⁾. The data were analyzed to calculate the Mean ± SE and ‘t’ test was applied to find out the statistical differences between the mean values.

RESULTS AND OBSERVATIONS

In present study the results and observations were recorded in different segments as given below: 1. Tunica mucosa or mucosal coat, 2. Tunica muscularis or muscular coat and 3. Tunica serosa or serous coat.

Tunica mucosa

Intramural segment: In all the tubes, mucosal folds showed very low primary folds like ridge and number folds were very few (Fig. 4 & 5). The epithelium consist of low columnar ciliated, non-ciliated secretory and peg-cells. The epithelial height were record for each fallopian tube and average height found in group-I and group-II, 28.43µm and 28.64µm respectively (Table:1 & 2), but difference between the two groups are statistically non-significant (Table: 3).

Isthmus: In all the tubes of both the group architecture of mucosal folds at isthmus segment present 4 to 6 primary folds with some secondary folds. The folds were medium to low in height and were almost conical in shape (Fig: 6&8). Epithelium consists of same three types of cells i.e., columnar ciliated, non-ciliated secretory and peg-cells but non-ciliated cells were predominant. Average epithelial height recorded in group-I and group-II was 29.60 and 29.78 respectively (Table: 1 & 2), but they were statistically non-significant (Table: 3).

Ampulla: During observation of mucosal folds it was observed that several primary, secondary and tertiary folds were present in the ampullary segment of the fallopian tubes of Group-I & II as villous pattern occupying most of the part of the lumen (Fig: 8&9). Epithelium consists of same type of cells with that of intramural and isthmus segment. Average epithelia height found in group-I and group-II, 33.26µm and 33.57µm respectively (Table: 1 & 2), but difference between the two groups are statistically non-significant (Table: 3).

Infundibulum: Arrangement of mucosal folds and epithelial structure was more or less same with that of ampullary segment but the folds were thin (Fig: 11&12). The epithelial height were record for each fallopian tube and average epithelial height found in group-I and group-II, 31.70µm and 32.08µm respectively (Table: 1 & 2), but difference between the two groups are statistically non-significant (Table: 3).

In each fallopian tube it was noted that maximum epithelial height (33.26µm and 33.57µm, Table:7&8) recorded at ampullary segment (Table: 10) and lowest at intramural segment (28.43µm and 28.64µm, Table:7,8 & 11) and represented by Bar diagram (Fig.13 & 14).

Tunica muscularis

Intramural segment: In both the groups muscle layer consisted of outer longitudinal and inner circular layer of smooth muscle fibers. In addition to the two muscle layers a prominent inner longitudinal muscle layer also observed (Fig: 4&5). The circular muscle layer is found to be thickest and well defined and separated from the outer longitudinal layer by vascular connective tissue namely by stratum vasculare.

Isthmus: The isthmus also exhibited similar outer longitudinal and inner circular layer of smooth muscle fibers separated by vascular connective tissue in all the fallopian tubes. But it was observed that the thickness of both the muscle layer was less than that of intramural segment (Fig: 9,10,12).

Ampulla: The ampullary segment of the oviduct in both the groups showed outer longitudinal and inner circular layer of smooth muscle fibers but no well defined demarcation between them and both the muscle layers were intermingled with each other (Fig. 12,14).

Infundibulum: In all the tubes infundibular region exhibited inner circular and outer longitudinal muscle layer of smooth muscle fibers but both the layers were very thin (Fig. 15). It was observed that the thickness of tunica muscular layer decreased gradually from intramural segment to infundibular segment in all the fallopian tubes.

Tunica serosa

It was noted that in both the groups the features of outermost serous coat were similar. It was made up of a layer of mesothelium which rest upon a subepithelial layer of connective tissue by which it was firmly united to the muscular layer and this portion contained large vessels and nerves (Fig. 8). The connective tissue of serosa consisted of interlacing strands of collagen fibres and sparsely distributed reticular fibres.

Table 1 Epithelial height (in μm) of Fallopian tube in Early Reproductive women (Group-I)

Number of specimen	Segments of fallopian tube			
	Intramural	Isthmus	Ampulla	Infundibulum
1	28.00	29.00	33.10	31.00
2	28.21	29.40	33.00	31.80
3	28.00	29.50	33.40	32.00
4	28.98	29.90	33.00	31.11
5	29.00	29.80	33.60	32.00
6	28.45	30.00	33.70	31.90
7	28.50	29.60	33.40	32.10
8	28.41	29.60	33.30	31.60
9	28.57	29.70	33.10	31.80
10	28.20	29.50	33.00	31.70
11	28.01	29.20	33.10	31.10
12	28.20	29.40	33.20	31.70
13	28.00	29.50	33.30	32.00
14	28.96	29.70	33.10	31.11
15	29.00	29.80	33.50	32.20
16	28.47	30.00	33.70	31.70
17	28.50	29.50	33.50	32.20
18	28.41	29.70	33.30	31.50
19	28.55	29.70	33.10	31.80
20	28.22	29.50	33.00	31.70
21	28.00	29.10	33.10	31.00
22	28.18	29.30	33.00	31.60
23	28.03	29.50	33.40	32.20
24	28.94	29.80	33.00	31.21
25	29.00	29.90	33.60	32.00
26	28.45	30.00	33.70	31.80
27	28.54	29.60	33.40	32.10
28	28.42	29.50	33.30	31.60
29	28.56	29.70	33.10	31.80
30	28.20	29.60	33.00	31.70
31	28.00	29.10	33.10	31.00
32	28.19	29.30	33.00	31.80
33	28.02	29.60	33.40	32.00
34	28.93	29.90	33.00	31.31
35	29.00	29.70	33.60	32.00
36	28.50	30.00	33.70	31.70
37	28.48	29.70	33.40	32.10
38	28.43	29.50	33.30	31.60
39	28.53	29.70	33.10	31.80
40	28.24	29.30	33.00	31.70
41	28.00	29.20	33.10	31.00

42	28.21	29.40	33.00	31.80
43	28.00	29.50	33.40	32.00
44	28.96	29.90	33.10	31.11
45	29.00	29.80	33.50	32.00
46	28.47	30.00	33.60	31.90
47	28.47	29.70	33.40	32.10
48	28.44	29.60	33.30	31.60
49	28.57	29.70	33.20	31.80
50	28.20	29.40	33.00	31.70
Average	28.43	29.60	33.26	31.70

Table 2 Epithelial height (in μm) of Fallopian tube in Late Reproductive women Group-II)

Number of specimen	Segments of fallopian tube			
	Intramural	Isthmus	Ampulla	Infundibulum
1	28.50	29.50	33.50	32.70
2	28.60	29.90	33.21	32.10
3	28.00	29.50	33.60	32.60
4	28.70	30.00	33.30	32.00
5	29.00	30.50	34.00	32.30
6	28.90	30.00	35.00	31.90
7	28.50	29.60	33.50	32.30
8	28.60	29.60	33.13	31.60
9	28.70	29.70	33.50	31.80
10	28.50	29.50	33.00	31.90
11	28.50	29.50	33.50	32.10
12	28.60	29.90	33.21	31.70
13	28.00	29.50	33.60	32.00
14	28.70	30.00	33.30	31.20
15	29.00	30.50	34.00	32.20
16	28.90	30.00	35.00	31.70
17	28.50	29.60	33.50	32.30
18	28.60	29.60	33.13	32.50
19	28.70	29.70	33.50	31.80
20	28.50	29.50	33.00	31.70
21	28.50	29.50	33.50	32.70
22	28.60	29.90	33.21	32.10
23	28.00	29.50	33.60	32.60
24	28.70	30.00	33.30	32.00
25	29.00	30.50	34.00	32.30
26	28.90	30.00	35.00	31.90
27	28.50	29.60	33.50	32.30
28	28.60	29.60	33.13	31.60
29	28.70	29.70	33.50	31.80
30	28.50	29.50	33.00	31.90
31	28.50	29.50	33.50	32.10
32	28.60	29.90	33.21	31.70
33	28.00	29.50	33.60	32.00
34	28.70	30.00	33.30	31.20
35	29.00	30.50	34.00	32.20
36	28.90	30.00	35.00	31.70
37	28.50	29.60	33.50	32.30
38	28.60	29.60	33.13	32.50
39	28.70	29.70	33.50	31.80
40	28.50	29.50	33.00	31.70
41	28.50	29.50	33.50	32.70
42	28.60	29.90	33.21	32.10
43	28.00	29.50	33.60	32.60
44	28.70	30.00	33.30	32.00
45	29.00	30.50	34.00	32.30
46	28.90	30.00	35.00	31.90
47	28.50	29.60	33.50	32.30
48	28.60	29.60	33.13	31.60
49	28.70	29.70	33.50	31.80
50	28.50	29.50	33.00	31.90
Average	28.60	29.78	33.57	32.08

Table 3 Average Epithelial height (in μm) of Fallopian tube in Early and Late Reproductive women(Group-I & Group-II)

Group	Segments of fallopian tube			
	Intramural	Isthmus	Ampulla	Infundibulum
Group : I	28.43	29.60	33.26	31.70
Group : II	28.64	29.78	33.57	32.08
SE \pm	0.0977	0.3542	0.1619	0.1298
Value of 't'	2.046 NS	0.5363 NS	1.8535 NS	2.0796 NS

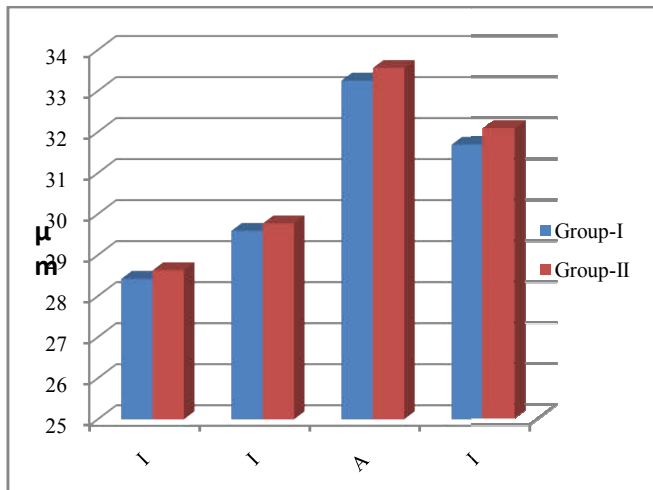


Fig 1 Bar diagram showing intergroup variation of Epithelial height of Intramural, Isthmus, Ampulla and Infundibulum segment of Fallopian Tube



Fig 2 Photograph of fallopian tube of 25 years old woman



Fig 3 Photograph of fallopian tube of 35 year old woman

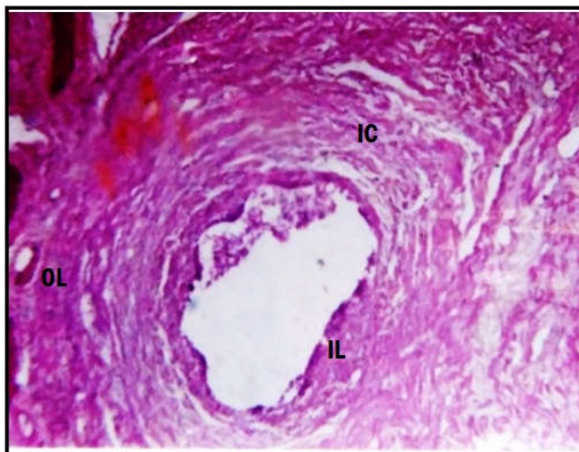


Fig 4 Photomicrograph of intramural segment of fallopian tube of Group-I showing different layers of muscle fibers (OL-outer longitudinal, IC-inner circular, IL-innermost longitudinal (Magnification x 100)

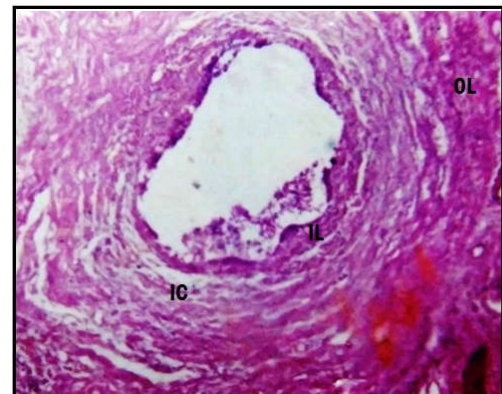


Fig 5 Photomicrograph of intramural segment of fallopian tube of Group-II showing different layers of muscle fibers (OL-outer longitudinal, IC-inner circular, IL-innermost longitudinal Magnification x 100)

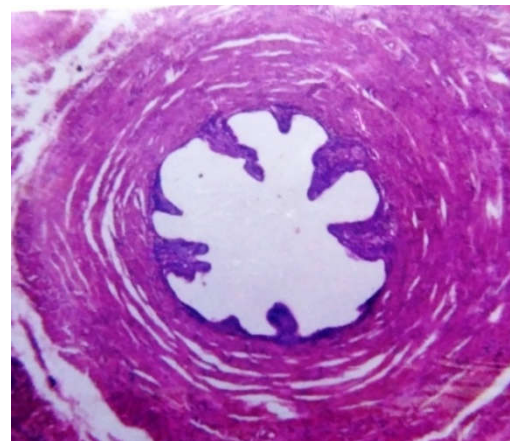


Fig 6 Photomicrograph of isthmus segment of fallopian tube of Group-I showing primary folds (Magnification x 100)

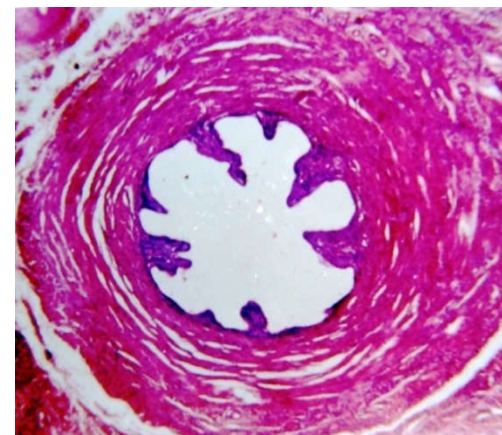


Fig 7 Photomicrograph of intramural segment of fallopian tube of Group-II showing primary folds (Magnification x 100)

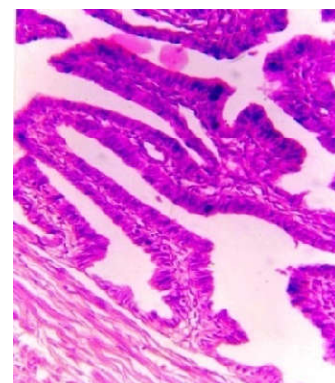


Fig 8 Photomicrograph of Ampulla of fallopian tube of Group-I showing mucosal folds occupying the most of the space of the lumen (Magnification x 200)

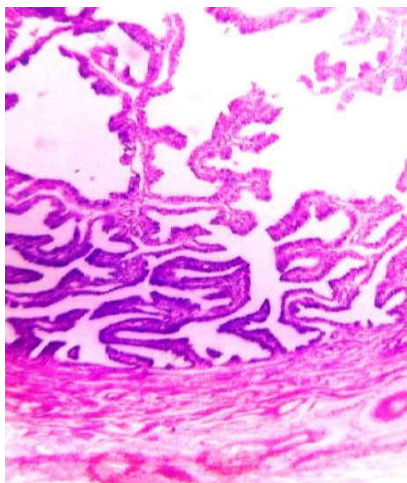


Fig 9 Photomicrograph of Ampulla of fallopian tube of Group-I showing mucosal folds occupying the most of the space of the lumen (Magnification x 100)

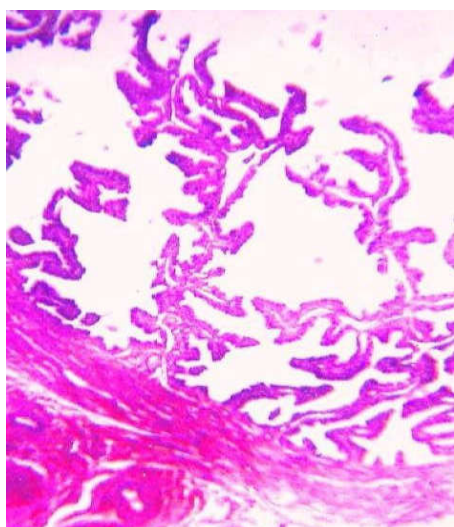


Fig 10 Photomicrograph of Infundibulum of fallopian tube of Group-I showing mucosal folds & thin musculature (Magnification x 100)

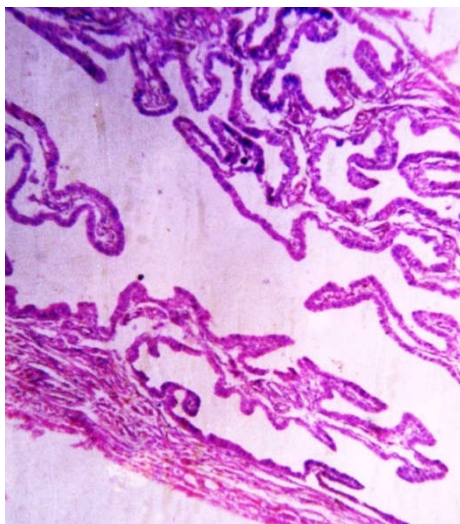


Fig 11 Photomicrograph of Infundibulum of fallopian tube of Group-II showing mucosal folds & thin musculature (Magnification x 100)

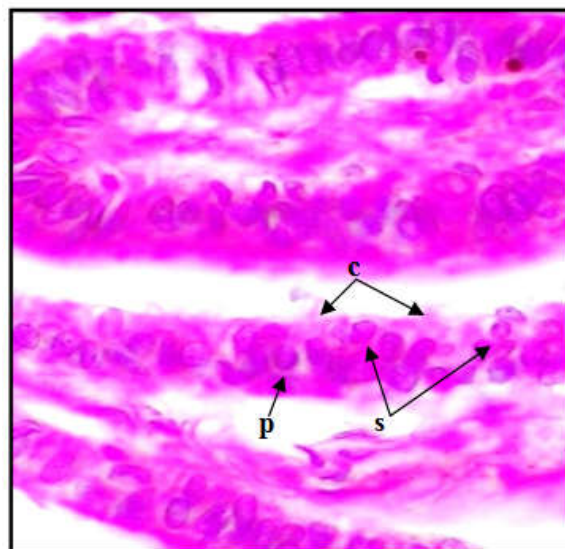


Fig 12 Photomicrograph of ampulla of Reproductive fallopian tube showing columnar ciliated (c), secretory (s) and peg (p) cells magnification x 400

DISCUSSION

Results and observations of present study revealed several points of interest having marked importance in practical life.

Tunica mucosa

Intramural segment: Arrangement of mucosal folds in both the groups at intramural segment showed low primary folds like ridges and number of folds were very few (Fig. 5,6,8) which corroborate with the findings of some research workers⁽¹³⁾.

Isthmus: Pattern of mucosal folds at isthmus in all the tubes exhibited four to six primary folds with some secondary folds. The folds were medium to low in height and conical in shape (Fig. 8 & 9) which has also been ascribed by several researchers^(13,14).

Ampulla: In ampullary segments in all the tubes showed very complex arborisation of mucosal folds having primary, secondary and tertiary folds occupying most of the part of lumen (Fig. 12, 13,) which is similar with findings of some workers^(14,15). With regard to the epithelial height it is obvious that among all the segments within the same uterine tube, maximum in ampullary segment whereas least height was noted in the intramural segment. These observations were also accorded with some workers^(16,17).

Infundibulum: Arrangement of mucosal folds and epithelial structure was more or less same with that of ampullary segment but the folds were thin^(15,16) (Fig. 19).

With regard to the epithelial height, it is evident that (Table. 13 & Fig. 22) in all the tubes epithelial height was maximum in ampullary segment (Table. 10) whereas least height was recorded in the intramural segment (Table. 1). Similar observations were noted by some workers^(13,14,15). Maximum epithelial height of ampulla may be explained in the light that ampulla is normal site of fertilization.

Tunica muscularis

In all the tubes in all the segments musculature consisted of inner circular and outer longitudinal layer of smooth muscle fibres but in intramural segment one prominent inner

longitudinal muscle layer also observed (Fig: 4&5). Similar findings observed by most of the investigators^(6,13,18)

From the present study it is revealed that the thickness of tunica muscular layer decreased gradually from intramural segment to infundibular segment in all the fallopian tubes which corroborates with the findings of other workers^(14,19).

Tunica serosa

The outermost serous coat of the uterine tubes exhibited similar features in all segments in all the tubes. It was made up of a layer of mesothelium which rests upon connective tissue layer containing large vessels and nerves (Fig.8 & 15). The connective tissue of the serosa was found to be consisted of interlacing strands of collagen fibres and sparsely distributed reticular fibers. All these features corroborate with that of some researchers^(6,14).

CONCLUSION

The present study has highlighted the differences of fallopian tubal epithelial height in different segments of fallopian tube in both the groups of reproductive age. Highest epithelial height found in the ampullary segment and least was recorded in the intramural segment. Thickness of muscle layer is in gradual decreasing trend from intramural part to infundibular segment, which is inversely proportionate to the epithelial height.

In the present days as infertility is one of the major topic of research, tubal involvement being a common cause, the present study on fallopian tube may open scope for the recent technique of 11 treatment like assisted reproductive technology (ART)⁽²²⁾, gamete intra fallopian transfer (GIFT) and zygote intra fallopian transfer (ZIFT) for infertility. Further studies need to be undertaken with more advanced techniques to know more about the segmental variation of histological architectures of fallopian tube in reproductive age. Moreover, the present study has opened scopes for investigation and treatment of infertility cases as well as diseases of fallopian tube.

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