

The Microstructure of Oviduct in Laying Turkey Hen as Observed by Light and Scanning Electron Microscopies

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Abstract: In the sexually active bird the oviduct is a tortuous tube extending from the single ovary to the cloaca and occupying a large part of the abdominal cavity. Distinctive structural variation at different levels allows its subdivision into five principle parts as infundibulum, magnum, isthmus, shell gland and vagina. The morphologic characteristics of the oviduct in 8 mature laying turkey was studied by light and scanning electron microscopies. Result revealed that the mucosal membrane of the oviduct possesses the complex luminal folds covered by ciliated columnar epithelium with secretory cells. The infundibulum presented a cranial opening with thin and long fimbriae. The luminal side showed distinct longitudinal primary and secondary folds. In the magnum, the folds were thicker and filled with tubular glands. It's luminal side had longitudinal broad folds. The isthmus is short and had fewer folds. The isthmal folds were less voluminous than in the magnum. A bag shaped uterus showed thin folds. In the luminal side primary folds with discrete secondary folds were seen. The vagina had long transverse luminal folds with no gland and thick muscular tunic. In conclusion the oviduct in laying turkey has morphological similarities with the other species of birds' except in some few points.

Key words: Oviduct • Turkey • Light Microscopy • SEM

INTRODUCTION

The term oviduct in the avian is used to describe the entire reproductive duct. Only the left oviduct is present in the adult. The development of the right oviduct of female is totally arrested very early in embryonic life. The left oviduct consists of the infundibulum, magnum, isthmus, uterus and vagina, each of these divisions has special structural and functional features.

The surface morphology of the oviduct in bovine [1] and porcine [2] was examined by scanning electron microscopy. The macroscopic and microscopic anatomy of the oviduct in the sexually mature *Rhea* was described by Parizzi *et al.* [3]. The structure and function of some parts of oviduct has been demonstrated in some birds, such as domestic fowl [4,5], Japanese quail [6], the guinea fowl [7], the pied myna [8] and immature ostrich [9]. In addition, information is available on the maturation of magnum in the quail [10], domestic fowl [11] and the ostrich [12].

The morphological investigation on the reproductive organs of the turkey is very scarce. In the following study, the surface region of the laying turkey's left oviduct were examined macroscopically and microscopically by light and scanning electron microscopies.

MATERIALS AND METHODS

Oviducts of 8 adult female laying turkeys were collected from the slaughterhouse. The oviducts were then cut longitudinally to expose the luminal surface, for evaluation of the different region of this organ. The oviducts were divided into 5 parts (infundibulum, magnum, isthmus, uterus and vagina). Subsequently, each part was divided into 2 parts. One part was fixed in 10% buffer neutral formalin for light microscopy. The other part was fixed in 2.5% glutaraldehyde for SEM study.

All fixed specimens were processed and sectioned 6 µm through light microscopic analysis.

The sections were stained by Hematoxylin & Eosin and Green Masson's Trichrome [13].

For scanning electron microscopy, after the fixation, the specimens were washed with sodium cacodylate, post fixed with 1% osmium tetroxide. They were dehydrated with graded series of ethanol. Clearing was carried out with methyl desialasan. Then the specimens were dried vacuum and critical point drying. They were mounted onto stubs using conductive double sided adhesive tape and then coated with gold for 45 second and examined under a scanning electron microscope (Hitachi HHS-2R).

RESULTS

In the laying turkey, the left oviduct is highly convoluted muscular duct, 72.8 ± 5.3 cm long, which extends from the ovary to cloaca and fills most of the dorsal and caudal part of the left side of the celomic cavity. It is suspended from the left side of the abdominal cavity by a thin, folded dorsal ligament which continues round the duct to form the ventral ligament; both contain smooth muscle fibers (Fig. 1). Macroscopically the oviduct consists of five distinct regions: infundibulum, magnum, isthmus, uterus and vagina. The dimension of each part is given in table 1.

Infundibulum: The infundibulum is composed of a thin walled funnel and a neck region. The mucosa- submucosa is made longitudinal ridges which is named primary folds. Secondary folds are only seen in the caudal part of infundibulum. The epithelium has 4 types of cells: non-secreting ciliated cells, non-ciliated goblet cells, secretory cells, especially in the depth of the clefts and tubular gland cells which are simple low columnar. The lamina propria- submucosa is loose collagenous tissue and highly vascularized. The tunica muscularis and tunica serosa are typical. The SEM analysis revealed that, there are spirally oriented longitudinal ridges increased in depth toward magnum and small secondary folds are seen on the primary ridges. Mucosal crypts appeared as deep infolding of epithelium (Figs 2A, 2B).

Table 1: Average dimension of the regions of oviduct in actively-laying turkey

Regions of the oviduct	Length (cm)
Infundibulum	7
Magnum	36.3
Isthmus	9.1
Uterus	9.4
Vagina	11
Total	72.8

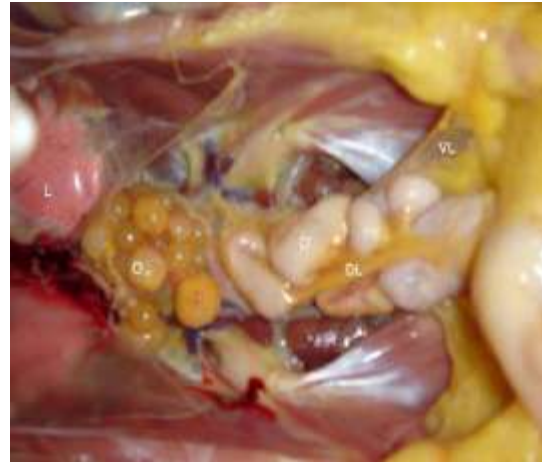
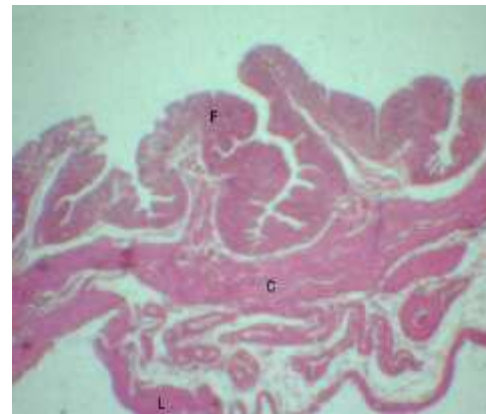
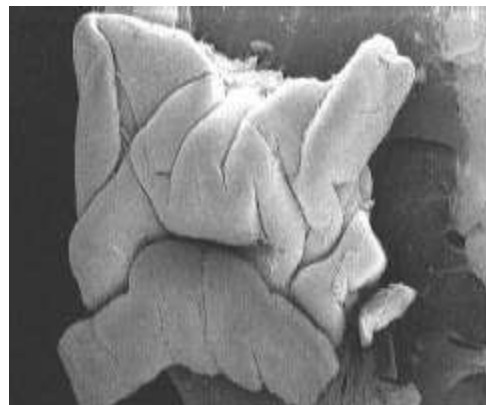


Fig 1: Photograph of ovary (O) and oviduct (O') in the laying turkey.

DL- Dorsal Ligament, VL- Ventral Ligament, L- lung.



(A)



(B)

Fig 2: A) Transverse section through infundibulum. The low mucosal folds (F) only comprise a minor part of the thickness of the wall, the reminder being composed of a loose circular muscle layer (C) and a more compact longitudinal layer (L). H & E, $\times 53$. B) Tortuous primary folds with a narrow furrow between them in the infundibulum, $\times 17480$.

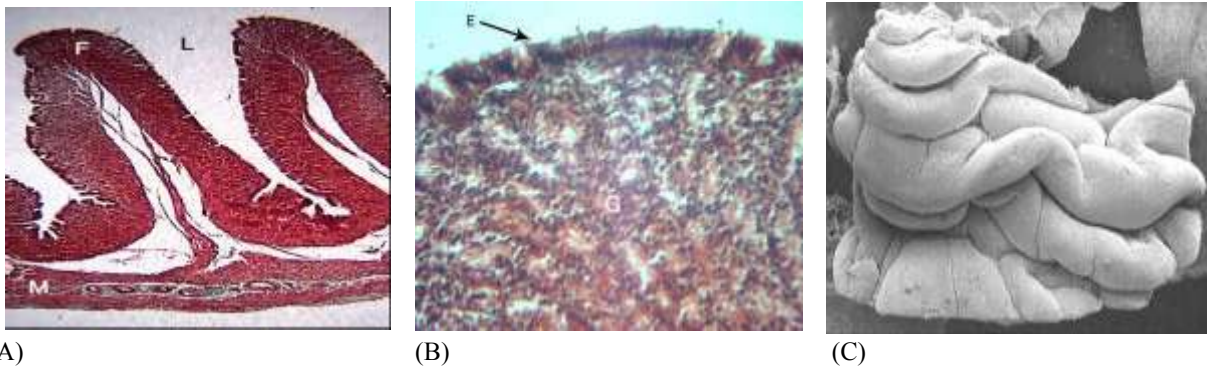


Fig 3: A) Photomicrograph of the magnum demonstrating the considerable development of the mucosal folds (F) in relation to the muscular layer (M). The increased height and thickness of the mucosal folds is due to the intense development of the tubular glands. L-Lumen. Green Masson's Trichrome, $\times 32$.
 B) Lining epithelium (E) and tubular glands (G) of the magnum mucosa. In the tubular glands the cells are vacuolated and the glandular lumens are visible. Green Masson's Trichrome, $\times 670$.
 C) Scanning electron microscopy of the magnum showed longitudinal voluminous luminal folds, $\times 16000$.

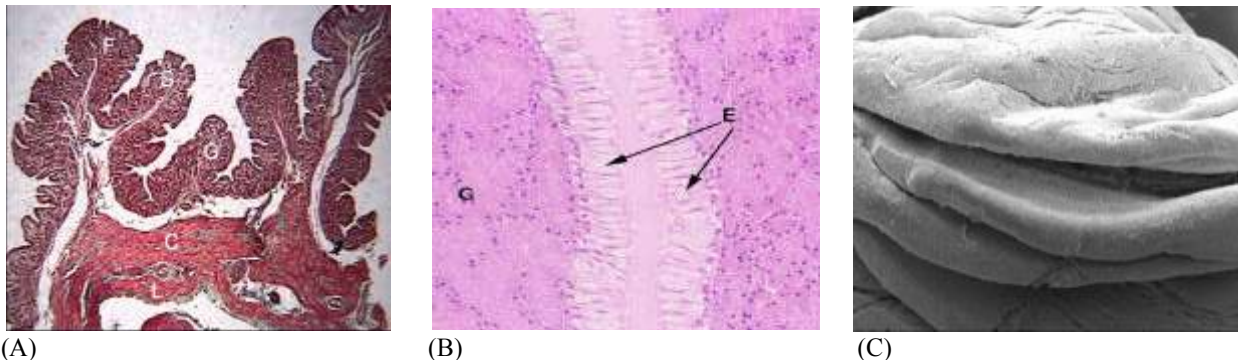


Fig 4: A) Photomicrograph of isthmus showing longitudinal primary mucosal folds (F) with secondary folds (S) contain tubular glands (G). The circular muscle layer (C) is well developed and is surrounded by a thinner longitudinal layer (L). Green Masson's Trichrome, $\times 32$.
 B) Photomicrograph of the mucosa surface epithelium (E) consists of ciliated and glandular cells. The tubular glands (G) are filled the folds. H & E, $\times 700$.
 C) Longitudinal orientation of folds with parallel furrows between them, $\times 45000$.

Magnum: The magnum is the longest and most conspicuous part and is easily distinguished from the infundibulum by its dull white color, greater external diameter and remarkably thicker wall. The epithelium of this part is simple columnar accompanied by ciliated and goblet cells. The lamina propria is rich in tubular gland. The glandular cells are pyramidal and contain apical granules. The muscular layers of the magnum are thicker and more clearly arranged in definite layers than in the infundibulum. The internal muscle layer is circular and the external layer has longitudinal orientation. In SEM analysis the magnum mucosal folds are more voluminous than elsewhere with the narrow clefts between them. In the proximal part of the magnum primary folds are accompanied by secondary and tertiary folds. But, in the distal part the folds are simple without secondary ones.

Numerous pits are seen which were presumed to be the glands openings. The boundary between the magnum and the isthmus is clearly delineated by a narrow, translucent zone with no tubular glands (Figs 3A, 3B, 3C).

Isthmus: The isthmus is relatively short section of the oviduct. Its diameter is less than that of magnum. The epithelium is simple columnar with ciliated and goblet cells. The propria- submucosa is filled with branched tubular glands. The tunica muscularis consists of circular and longitudinal smooth muscle layer. The serosa consists of loose connective tissue and mesothelium. The SEM study revealed that the folds are in longitudinally orientation and the parallel rows of discontinuous furrows were observed. These folds are branched with secondary and tertiary ones (Figs 4A, 4B, 4C).

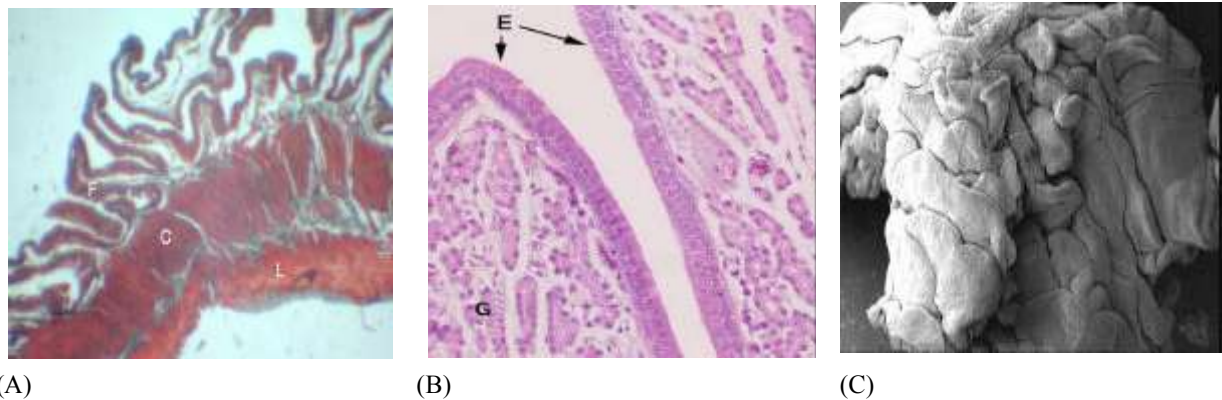


Fig 5: A) Low power photomicrograph showing the structure of the uterus. The wall is composed of well developed longitudinal (L) and circular (C) muscle layers, with mucosa arranged in numerous leaf shaped folds (F). Green Masson's Trichrome, $\times 30$.
 B) Section through the mucosa of uterus. The surface epithelium (E) consists of apical, ciliated and basal cells. The tubular glands (G) are packed together and consist of 5-7 polygonal cells enclosing the lumen. H & E, $\times 580$.
 C) Compressed and longitudinal orientation of folds with voluminous interfold spaces. $\times 16500$.

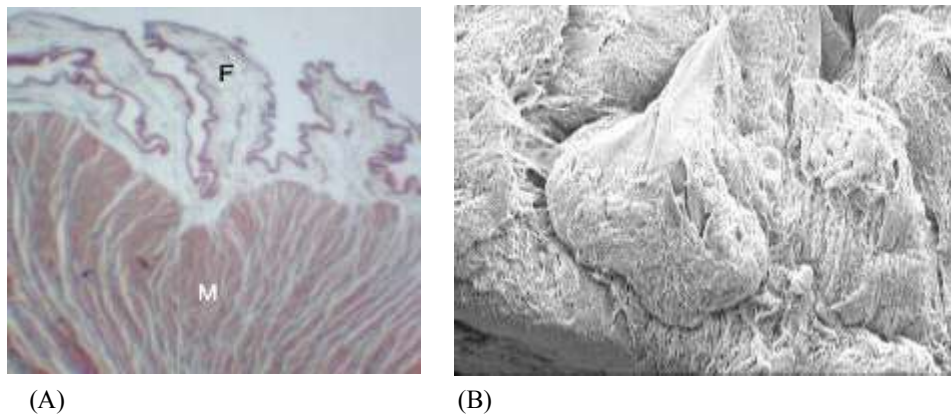


Fig 6: A) Transverse section through the vaginal wall. The mucosal folds (F) are long and slender with numerous small secondary folds superimposed upon them. The muscular layer (M) are composed of a thick, inner circular layer with scattered, longitudinal bundles arranged peripherally. Green Masson's Trichrome, $\times 33$.
 B) Transverse oriented mucosal folds which are covered with cuticle. $\times 48000$

Uterus: The uterus is an expanded portion of the oviduct. This part is less voluminous, but more fusiform than the isthmus. Its wall is thick and the tunica muscularis is well developed, especially the longitudinal layer. The epithelium is pseudostratified and is intermittently ciliated. The propria-submucosa contains branched tubular glands. Loose and well vascularized connective tissue is sparse between the glands. SEM study revealed that uterine mucosal folds are longer and more complex than the isthmus ones. These folds were more compressed and longitudinally oriented which were obscured by secondary circular folds. Abundant voluminous interfold spaces were seen between folds (Figs 5A, 5B, 5C).

Vagina: Vagina is the short and S-shaped tube and is the last portion of the oviduct. The mucosa of the vagina is coated by a ciliated pseudostratified columnar epithelium with many mucosa secretory cells. The mucosa of this part is raised into numerous, narrow, low longitudinal ridges. There is no tubular gland in the core of the folds. The great part of the thickness of the vaginal wall is composed of the muscular layers. The inner circular layers are strongly developed and form the vaginal sphincter. The outer longitudinal layer consists of bundles of muscle fibers scattered throughout a connective tissue stroma. The SEM study showed that the mucosal folds of this region were transversally

oriented and carrying secondary folds. The folds are narrower than in most other parts of the oviduct (Figs 6A, 6B).

DISCUSSION

The oviduct in turkey hen like other birds is a highly-convoluted, muscular duct, which is concerned with the transport of the ovum away from the ovary, with fertilization of the ovum and by the deposition of albumen, membranes and shell on to the ovum to form the finished egg. It extends from the single ovary to the cloaca and occupying a large part of the abdominal cavity. The normal functional oviduct of turkey like fowl and the other birds, develops from the mullerian duct of the left side. Winter [14] stated that the right oviduct occur frequently in normal birds as small, sometimes cystic; but fully developed right oviduct do occur. The turkey's oviduct like fowl [15] and rhea [3] have distinctive structural variations at different levels which subdivided it into five principle parts: Infundibulum, Magnum, Isthmus, Uterus and Vagina. In all portion of the oviduct, the luminal folds of the mucosa are covered by the ciliated epithelium with secretory cells and the opening of the tubular glands which is located in lamina propria submucosa. This pattern is also common in the fowl [16]. The first part of the oviduct, the infundibulum, possesses long spiral folds with few glands. The secondary folds are not as distinct as in fowls [15]. At the beginning of the magnum the epithelial folds become smaller and the glandular grooves disappear before the typical broad longitudinal folds of the magnum develops. This result is similar to that of the fowl [17], but different from the rhea [3]. In the rhea the glandular grooves become shorter but not disappeared.

Magnum –albumen secreting region- is the longest and most conspicuous part and is readily distinguished from the infundibulum by its dull white color, greater external diameter and thicker wall. The latter feature is the result of a massive increase in the lamina propria glandular tissue. The magnum has two functions: to transport the egg to the isthmus and to produce the albumen [16]. In the turkey, the magnum has high and wide folds, especially in the cranial portion, become lower when approaching to the isthmus. This result is similar to rhea [3]. In the domestic fowl [18], the size of the fold increase progressively in magnum-isthmus junction. The tubular glands in the magnum are very highly developed and open to the epithelial surface. It is similar to rhea [3] and different from domestic fowl [15]. The muscular layers of the magnum are arranged in definite

layer. The external layer has longitudinal orientation and the internal layer is circular; but in domestic fowl [15] the external layer seems to be oblique. In SEM study, the folds are distended and parallel rows of interrupted furrows were frequently observed. In the hen [5] the folds form a flat surface and is different from turkey and rhea [3].

The isthmus, contain a numerous tubular glands for secreting of the shell membrane [4,19] and the same concluded for the turkey. The muscular part of this region is like the other birds and only consists of a thin circular layer.

The uterus immediately succeeding the isthmus is of similar diameter, but after a short course, expands to form a pouch in which the egg retained during the entire period of shell formation. In the turkey, uterine mucosal folds are longer and more complex than the isthmian ones and as propria gland tissue is less voluminous, are narrower. In the hen [20] the mucosa of the uterus is ciliated pseudostratified and the nucleus of the cells arranged into two layer. In rhea's oviduct, the cranial area of the uterus, possess more tubular glands in relation to other segments and this characteristics are also described in the chicken [4]. In turkey unlike the chicken, the distribution of tubular glands is the same in the length of uterus.

The vagina is a relatively short, S-shaped tube which probably plays no part in egg formation. The length of vagina has been variously described in the fowl as 12-13 cm [21], 7-9 cm [22] or 6 cm [17]. In turkey, the vaginal length is 10-12 cm and it has one curvature. In the fowl's vagina we can see 2 [15] and in rhea's 3 curvatures [3]. The folds are firmly bound together and to the uterus. The mucosa forms longitudinal ridges or folds carrying secondary folds which are particularly regular in arrangement. In the turkey the folds are narrower than in most other parts of the oviduct due to the absence of glands. It is similar to that of fowl and rhea [3, 15].

In conclusion, each part of the oviduct has a complex activity during reproductive period. The results revealed that the turkey's oviduct are composed of tunica mucosa with longitudinal luminal folds, which covered by secretory and ciliated cells and glands, tunica muscularis by different thickness in different part and tunica serosa.

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