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Research Article

Morphology of the oviduct in Chukar Partridge (*Alectoris chukar*) during pre-laying and laying periods

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Abstract
This study was conducted to investigate the structural components of the female reproductive structures in Chukar partridge during the pre-laying and laying periods. The left oviduct was convoluted and muscular in the pre-laying and laying periods, but severely convoluted in the laying periods. Both had five regions: infundibulum, magnum, isthmus, uterus, and vagina. The infundibulum had two parts: the anterior half was large and funnel-shaped, and the posterior part was tubular-shaped known as the neck part. A fold was noted at the neck sections of the pre-laying (pre-laying was very thin and translucent) and expanded in depth toward the magnum, isthmus, and uterus (laying). The magnum's internal mucosal surface was oriented longitudinally. Pre-laying mucosal folds and invagination were less prominent, but during-laying folds were larger, more invaginated, and separated by indentations. The isthmus joined the magnum to the shell gland. The mucosal folds appeared larger, longer, more prominent, and longitudinally orientated in the laying than in the pre-laying. The uterus has two parts: an anterior tubular portion and a posterior pouch-like portion. Its walls were the thickest and widest in the oviduct. The uterine wall is thickest, broadest, and most distended during laying. Its inside surface exhibited circular leaf-like mucosal folds. The vaginal mucosal folds were organized differently and appeared white. The vaginal sphincter muscle in the early section of the vagina is responsible for releasing the egg from the cloaca into the external media.

Keywords: Bird, Morphology, Reproduction, Anatomy.

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Introduction

Partridge is a medium-sized non-migratory bird with a wide native distribution throughout the old World, including Europe, Asia, and Africa (Kimball et al. 1999). The reproductive system in birds consists of the left ovary and an oviduct that derives from the left Mullerian duct. The left oviduct is developed and becomes fully functional immediately before the onset of egg production (Suraj & Suhas 2009). The oviduct can be divided into six anatomically, histologically, and functionally distinct regions. The infundibulum produces a strong perivitelline membrane around the egg yolk; the magnum is responsible for the secretion of albumin; the isthmus forms a fibrous membrane known as the shell membrane around the albumin (white egg); the uterus is responsible for the secretion of eggshell due to the presence of tubular shell gland; the uterovaginal junction between the uterus and vagina, which contains sperm storage tubules, and the vaginal is the final part of the genital tract which connects the uterus to the cloaca (Al-Taai 2015; Khalaf 2019).

Morphohistological studies of the female reproductive system of Chukar partridges are scarce. Therefore, this study was conducted to investigate the main structural components of the female

reproductive structures and record the gross anatomical features of oviduct parts (infundibulum, magnum, isthmus, uterus, and vagina) in Chukar partridge during the pre-laying and laying periods.

Materials and Methods

The Chukar partridge birds were obtained from the commercial markets of Baghdad and Arbil, Iraq. The study included ten adult females in pre-laying and laying periods, all clinically healthy. The birds were slaughtered, then abdominal dissection was conducted to expose the viscera, which was subsequently removed to view the reproductive organs. The anatomical study included: anatomical description of the oviduct; shape and color of each part of the oviduct; weight, length, and width of each part.

Results and Discussion

The second main part of the reproductive system is the oviduct. The gross observation indicated that the left oviduct of the laying period has more developed. In both periods the parts extend from the ovary to the cloaca and occupy most of the caudal and dorsal parts of the left side of the coelomic cavity. It is fixed via the double fold of dorsal and ventral oviductal ligaments (Figs. 1, 2).

The examinations revealed that the left oviduct of the pre-laying and laying period is convoluted and muscular, but it is highly convoluted in laying periods. They were composed of five regions: the infundibulum, magnum, isthmus, uterus, and vagina (Figs. 3, 4). The results are confirmed by the findings of Khokhlov & Kuznetcov (2007), Moraes et al. (2010), Hassan (2013), El Gendy et al. (2016) and Abdul Wahhab (2017). Whereas Evencio-Neto et al. (1997) showed that the left side of the oviduct consists of six different regions of fimbriae, infundibulum, magnum, isthmus, and vagina in the muscovy duck. While Abood & Al-Saffar (2015) stated that the left side of oviduct consists of six regions of infundibulum, magnum, isthmus, uterus, junction region and vagina in the Mallard Duck.

In the pre-laying period, the internal mucosal surface of the left oviduct displayed longitudinal oriented mucosal folds at the neck region of the infundibulum. It continued into the vagina, whereas in the laying period, the internal mucosal surface of the left oviduct displayed clear variable numbers of longitudinal and circular oriented mucosal folds that extended along the entire length and projected especially in the regions of the neck, magnum, isthmus, and uterus (Figs. 5, 6). These results agree with the findings of Neelamm et al. (2010), Hassan (2013) and Al-Taai (2015), who mentioned the longitudinal orientation of the mucosal folds. These folds' arrangement and orientation have suggested that they evolved their mechanical role in transporting egg mass. They also provided a wide surface area for normal albumin deposition by magnum and isthmus and eggshell in the uterus. The mean weight and length of Chukar partridge oviduct parts were lower than turkey (Parto et al. 2011) and duck (Mohammadpour 2007). While these parameters in Chukar partridge oviduct parts were similar to those of pigeons (*Colomba livia domestica*) (Hassan 2013), this is due to the species variations and may be related to the size of the bird.

The infundibulum in the pre-laying and laying period was composed of two parts; the cranial part was wide and funnel-shaped, and the second part was the caudal tubular part, namly the neck part. This result is similar to Sharaf et al. (2012) finding in ostrich hens and Abdul Wahhab (2017) in barn owls. The internal mucosal surface of the funnel part was very thin and translucent in pre-laying and laying, with no notable folds, and the funnel showed whitish folds; however, the folds of the laying were distinguished at the neck parts, which increased in depth toward the magnum, isthmus, and uterus (Figs. 5, 6).

The weight, length, and width of the funnel part were 0.254 and 0.040g, 6.960 and 1.418mm, and 7.680 and 0.641mm in the pre-laying period, respectively, while the weight, length, and width of the funnel part were 0.674 and 0.105g, 25.640 and

Table 1. Show the weight, length, and width of the oviduct regions in the chukar partridge at Pre-laying and laying periods (Mean ± SD).

parameters / organs	Weight/gm		Length / mm		Width/mm	
	Pre- laying	laying	Pre-laying	laying	Pre-laying	laying
Funnel	0.254 ± 0.040*	0.674 ± 0.105	6.960 ±1.418*	25.640±2.485	7.680±0.641*	10.382 ± 0.471
Neck	0.276 ± 0.043*	1.378 ± 0.346	5.220 ±1.249*	15.420 ±2.294	2.880±0.683*	6.878 ± 0.360
Magnum	0.686 ± 0.126*	6.842 ± 0.384	47.596±3.752*	165.860±9.186	4.340± 0.665*	9.154 ±0.800
Isthmus	0.176 ± 0.023*	0.266 ± 0.073	7.545 ± 1.301*	26.280 ±2.146	3.460± 0.554*	8.412 ±1.425
Uterus	0.448 ± 0.092*	2.640 ± 0.287	10.660±1.742*	33.940±2.446	7.420±0.837*	10.204 ± 0.594
Vagina	0.288 ± 0.027*	1.552 ± 0.227	6.720 ± 1.553*	17.040 ±1.619	5.140±0.712*	9.938±0.347

*denote significant differences horizontally ($P \leq 0.05$ and $P \leq 0.01$) between means at the pre-laying and laying periods.

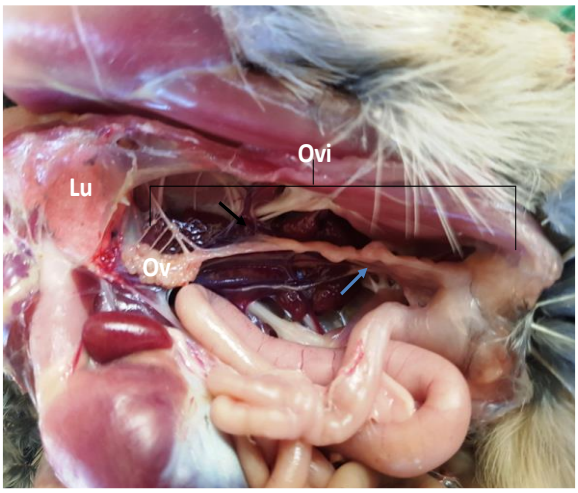

Fig. 1. Gross appearance of female genital system of chukar partridge shows: ovary (Ov), oviduct (Ovi), Lung (Lu), dorsal oviductal ligament (black arrow) and Ventral oviductal ligament (blue arrow).

2.485mm, and 10.382 and 0.471mm in the laying period (Table 1). The length and diameter of the infundibulum were approximately similar to those recorded by Hassan (2013) in pigeons, while the length was less compared to immature and mature ostriches or mature hens (Khokhlov 2008; Sharaf et al. 2012). The weight, length, and width of the neck part in the pre-laying period were 0.276 and 0.043g, 5.220 and 1.249mm, and 2.880 and 0.683mm, respectively, while in the laying period, the weight, length, and width of the neck part were 1.378 and 0.346g, 15.420 and 2.294mm, and 6.878 0.360mm, respectively (Table 1).

The magnum was the longest and most flexuous part of the oviduct. This finding is consistent with Sultana et al. (2003) in quail, Parizzi et al. (2008) in sexually mature rhea Moraes et al. (2010) in maraca, Parto et al. (2011) in laying turkey, and Mahmud et al. (2017) in laying chicken. The internal mucosal surface showed a longitudinally oriented direction. The mucosal surface showed fewer mucosal folds and invagination during the pre-laying period. In contrast, the largest part of the laying period, the mucosal folds had more invagination and were separated by indentations (Figs. 5, 6, 7, 8). In the pre-laying period, the weight, length, and width of the magnum were 0.686 and 0.126g, 47.596 and 3.752mm and 4.340 and 0.665mm, respectively, whereas, in the laying period, the weight, length, and width of the magnum were 6.842 and 0.384g, 165.860 and 9.186mm, and 9.154 and 0.800mm, respectively (Table 1). The magnum was the longest and most coiled part in the pre-laying and laying periods, a character observed in other avian species. However, its whole length was the shortest compared to some other birds. The variation may be credited to species variation and the size of birds. The mucosa of magnum had obvious longitudinally oriented mucosal folds. It was larger than the other regions of the oviduct, a feature shared by other birds such as

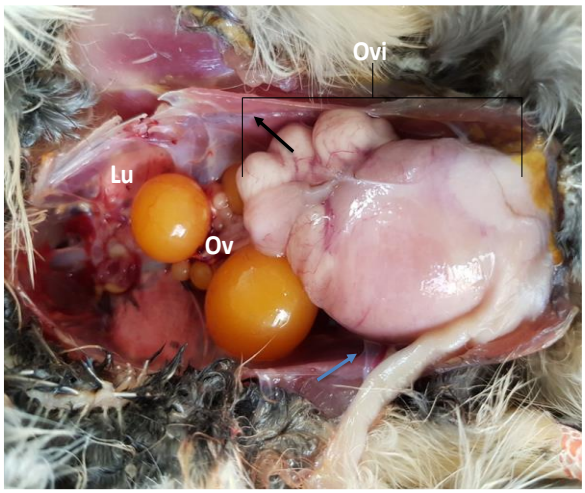

Fig. 2. Gross appearance of female genital system of chukar partridge shows: ovary (Ov), oviduct (Ovi), Lung (Lu), dorsal oviductal ligament (black arrow) and Ventral oviductal ligament (blue arrow).

Fig. 3. Macrograph of pre-laying oviduct in chukar partridge, macrograph shows ovary (Ov), funnel (F), Neck (N), magnum (M), isthmus (I), anterior part of uterus (a), pouch part of uterus (P) and vagina (V), cloaca (black arrow).

(Sultana et al. 2003) in Japanese quail, (Madekurozwa 2005) in ostrich, and (Al-Taai 2015) in Mallard Duck.

Isthmus is the third, less convoluted region with whitish colour, thin in the wall, and thinner than the magnum. It was a narrow tube that connected the magnum to the shell gland. In the pre-laying, the mucosal surface appeared smaller and very short, whereas, in the laying, the mucosal folds appeared larger, longer, more prominent, and longitudinally oriented (Figs. 5, 6, 7, 8). In pre-laying, the isthmus's weight, length, and width were 0.176 and 0.023g, 7.545 and 1.301mm, and 3.460 and 0.554mm, respectively. While in laying, the isthmus's weight, length, and width were 0.266 and 0.073g, 26.28 and 0 2.146mm, and 8.412 and 1.425mm, respectively (Table 1). In the pre-laying and laying periods, this region was shorter and less coiled than a magnum, and their length and diameter were similar to those found in the barn owl (Abdul Wahhab 2017), in pigeons (Hassan 2013) and in the balady duck (EL Gendy *et al*. 2016). However, these values were less than those found in hens (Mohammadpour et al. 2012), duck native chickens (Mishra et al. 2014), and ostriches (Sharaf et al. 2013). A narrow band of tissue sharply distinguishes the boundary between the isthmus and magnum. This is related to the declarations of Hodges (1974) and King & Mclelland (1984).

The uterus is a fourth portion of the oviduct. In

Fig. 4. Macrograph of laying oviduct in chukar partridge, macrograph shows ovary (Ov), funnel (F), neck (N), magnum (M), isthmus (I), Anterior part of uterus (a), Pouch part of uterus, vagina (V), demarcation between magnum and isthmus (black arrow).

Fig. 5. Macrograph of oviduct regions (pre-laying chukar partridge) shows inner parts of funnel (F) neck (N), magnum (M), isthmus (I), uterus (U), vagina (V), mucosal folds (Black arrows).

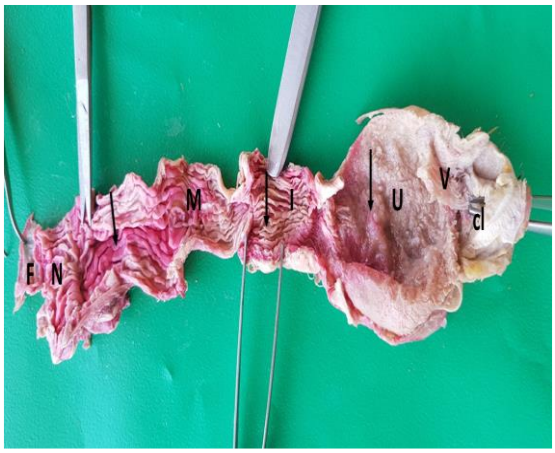

Fig. 6. Macrograph of oviduct regions (laying chukar partridge) shows inner parts of funel (F), neck (N), magnum (M), isthmus (I), Uterus (U), and vagina (V) and mucosal folds (Black arrows).

pre-laying and laying periods, the uterus was reddish. It consists of a short anterior tubular part and an expanded posterior pouch-like part. Because of the egg, more time is spent in this part than in the eggshell, which is formed by shell glands in the uterus. Its walls were thickest and widest compared

Fig. 7. Macrograph in oviduct (pre-laying chukar partridge) shows: the inner parts of neck (N), magnum (M), Isthmus (I), mucosal folds (Black arrows).

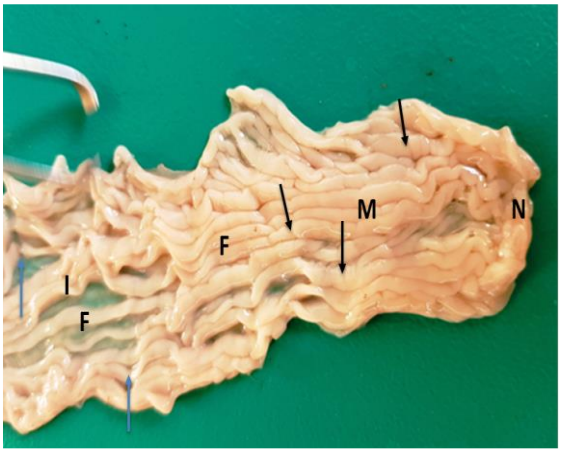

Fig. 8. Macrograph of oviduct (laying chukar partridge) shows: inner parts of neck (N), magnum (M), and isthmus (I), mucosal folds (F), indentations (blue arrows), invagination (black arrows).

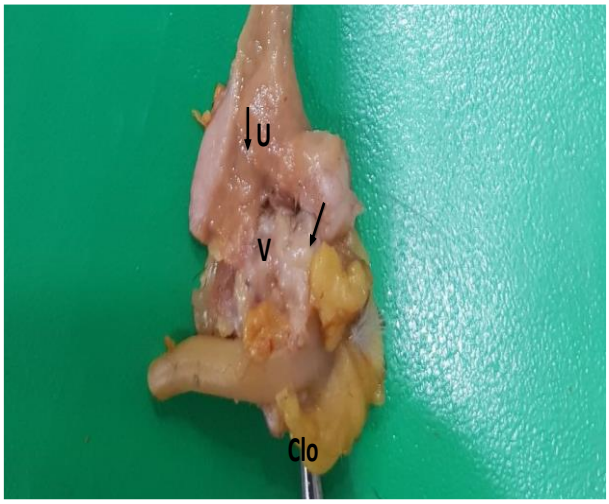

Fig.9. Macrograph of oviduct in pre-laying chukar partridge shows inner parts of uterus (U), vagina (V), mucosal folds (Black arrows).

to other regions of the oviduct. Also, the uterus in the laying period shows the thickest, widest, and most distended wall. Its internal surface had leaf-like separated mucosal folds oriented in circular directions (Figs. 9, 10). In pre-laying, the uterus' weight, length, and width were 0.448 and 0.092g,

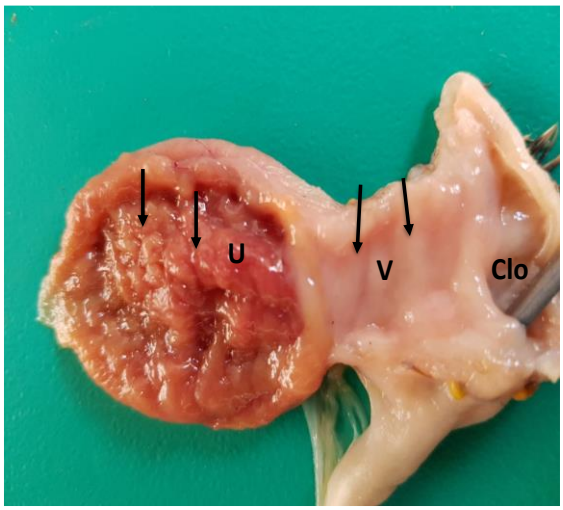

Fig. 10. Macrograph of oviduct inlaying chukar partridge shows: uterus (U), vagina (V) cloaca (Clo), mucosal folds oriented in circular directions (Black arrows).

10.660 and 1.742mm, and 7.420 and 0.837mm, respectively. While in laying, the uterus' weight, length, and width were 2.640 and 0.287g, 33.940 and 2.446mm, and 10.204 and 0.594mm, respectively (Table 1). The length of the uterus in the present work nearly similar to other species such as pigeons (*Colomba livia domestica*) (Hassan 2013) and Japanese quail (Majama et al. 2016). The length of the uterus in chukar partridge was shorter than those of mature geese (Mohammed 2010), geese, and guinea fowl (Khalaf 2019). The uterus (shell gland) is separated from the vagina via a narrow groove of sphincter muscle which appears in the laying period. This result is similar to findings of Fujii (1963), Mcleod et al. (1964) and Abdul Wahhab (2017), who found that the uterovaginal junction seems to act as a sphincter muscle that prevents the ova position from the uterus.

The vagina is the short and terminal part of the oviduct. It is a short straight tube with a thickened muscular wall connected to the cloaca posteriorly (Figs. 9,10). This result agrees with the results of Al-Taai (2015), Abdul Wahhab (2017) and Khalaf (2019), and disagree with the results of Bakst et al. (1994), Jacobs & Bakst (2007), Ferdous et al. (2011), and Alshammary et al. (2017) who stated that the vagina in adult in ISA brown chickens, laying turkeys, and geese have a short S-shaped tubal region. Sharaf (2013) showed that in laying hens, the vagina is a curved tube opening in the urodeum of the cloaca. Its mucosal folds were arranged in a different direction and appeared white. In the chukar partridge, the vaginal sphincter muscle situated in the first part of the vagina is responsible for the passage of the egg into and out of the cloaca into the external medium. This is similar to the reports of Bacha & Bacha (2003) and Saber et al. (2009). In pre-laying, the weight, length, and width of the vagina were 0.288 and 0.027g, 6.720 and 1.553mm, and 5.140 0.712mm, respectively. The weight, length, and width of the vagina during laying were 1.552 and 0.227g, 17.040 and 1.619mm, and 9.938 and 0.347mm, respectively (Table 1). This was nearly identical to the findings of Hassan (2013) in pigeons and Majama et al. (2016) in Japanese quail. The length and diameter of the vagina in pre-laying and laying periods were shorter than those of adult ISA brown chickens (Ferdous et al. 2011) and mature geese (Mohammed 2010).

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