RESEARCH ARTICLE

Postnatal Changes in Morphology and Morphometry of Testis of Guinea Fowl *(Numida meleagris)*

Tamilselvan S[1*], Meena Mrigesh[2], Ishwar Singh[3]

Abstract

This work was carried out on testes of 54 apparently healthy male guinea fowl (Pearl variety) at different age groups from Day old to 28 Weeks at monthly interval. The testes are paired organs, located within the abdominal cavity attached to the dorsal body wall by mesorchium. After hatching at day old age, the testes were indistinct and very difficult to demarcate. From 24 weeks onwards abundant fat tissues were observed in and around the testes and associated regions. They were small rice sized upto 8 weeks of age followed by elongated bean shaped, white to creamy white in colour from 12 to 28 weeks of age. The weight, length, width, and volume of guinea fowl testes increased as the age advanced till 28th week of observation.

Key words: Guinea fowl, Morphology, Morphometry, Postnatal, Testis.

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Introduction

Poultry industry provides supplementary income and employment as well as nutritional security to many poor and small farmers in developing countries of Asia (Sathe, 2002). The guinea fowl is a gallinaceous bird, which is native to Africa. Guinea fowl can be utilized as low input-grain saving poultry alternative for production (Tamilselvan *et al*., 2020). Koney (1993) reported that the guinea fowls have a higher dressing percentage and are leaner than chickens. They also yield firmer and tastier meat than chickens. Apart from this, these birds are known to be resistant to various poultry diseases as well as heat stress, which improve their adaptive capabilities to extreme harsh climatic conditions (Butcher *et al.,* 2009; Ikani and Dafwang, 2004). Testes are the major male reproductive organs, which are involved in sperm production. Artificial insemination has nowadays become an essential part of poultry farm reproduction. Its adoption in poultry sector has led to increased popularity, particularly in the field of research and commercial purposes (Dobrinski, 2005). Hence, the present study was undertaken to provide age wise gross morphological and morphometrical changes of testes in guinea fowl.

Materials and Methods

The study was conducted in testis from 54 apparently healthy male Guinea fowl birds (Pearl variety) at different age groups, *viz*., Day old, 2, 4, 8, 12, 16, 20, 24 and 28 weeks with six birds in each group, procured from the Instructional Poultry Farm (IPF) of the College. The study was carried out in the Department of Veterinary Anatomy, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, Pantnagar-263145, Uttarakhand (India) following approval of Institutional Animal Ethical Committee.

[1-3]Department of Veterinary Anatomy, College of Veterinary and Animal Sciences, GB Pant University of Agriculture &Technology, Pantnagar-263145, Uttarakhand, India.

Corresponding Author: Dr. Tamilselvan S, Assistant Professor, Department of Veterinary Anatomy, Veterinary College and Research Institute, Theni- 625 534, TANUVAS, Tamil Nadu, India. E-mail: tselvan64@gmail.com

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The birds of specified age groups were sacrificed as per the guidelines of CPCSEA. The abdomen was opened carefully for the approach of male reproductive organs. Then the general morphology and topographical relations in situ of testes was studied and subsequently photographed. The organs were removed from the abdominal cavity after careful dissection and washed in normal saline and mopped with blotting paper. The gross morphologies like location, shape and colour of testis and morphometric parameters like Weight, Length, Width and Volume of right and left testes were recorded. The organs were weighed by using a digital weighing balance (Sartorius, TE 214 S). Length and width of the organs were measured by digital Vernier caliper. Volume of the organ was measured by Archimedes' Principle of water displacement method and the results were recorded in cubic centimeter (Bath and Chaudhari, 2002). The data collected were analyzed by using IBM-SPSS Statistics version 20 software by one way analysis of variance (ANOVA) and differences were significant if p was ≤ 0.05 and means were

separated using Tukey's test. The differences between right and left variables were determined using paired "t" test.

Results and Discussion

Gross Morphology of Testes

The testes of guinea fowl were covered by a layer of peritoneum (Fig. 1) in all the age groups as reported earlier in quails (Al-Tememy 2010; Kannan *et al*., 2015). The testes contained a central slightly depressed area called hilus region, through which the testicular arteries from the caudal aorta gave supply (Fig. 2). The testes were attached to the dorsal body wall by small peritoneal fold called mesorchium, which allowed certain movements and adjacent organs contributed to their in-situ position maintenance as stated in domestic fowl (Bull *et al.,* 2007). The peritoneal fold not only acted as an attachment for the testes but also as a penstock for nerves and vessels. It confirmed the findings of Banerjee (1991) in fowl and Dyce *et al.* (2009) in birds.

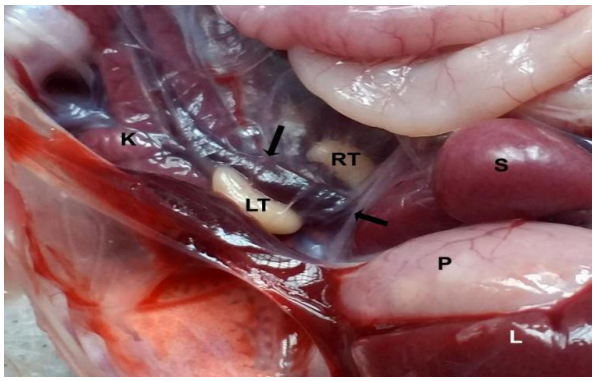

Fig. 1: Peritoneal covering (Black arrows) around the testis in 12 weeks old Guinea fowl. Left testis (LT), Right testis (RT), Spleen (S), Proventriculus (P), Liver (L) and Kidney (K)

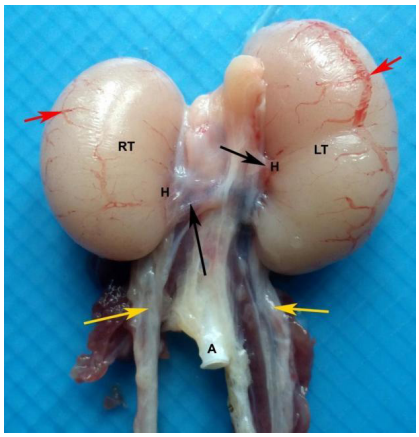

Fig. 2: Testis of 28 weeks old Guinea fowl. Left testis (LT), Right testis (RT), Hilus (H), Ductus deferens (Yellow arrows), Aorta (A), Testicular arteries entering through hilus (Black arrows) and Blood vessels on tunica albuginea (Red arrows)

The guinea fowl testes contained two surfaces (ventral and dorsal), two borders (lateral and medial) and two extremities (cranial and caudal) (Fig. 3). Both testes were covered with tunica albuginea, which was a firm, dense, transparent, and thin layer. No septa were formed and no lobes or mediastinum were observed in the testes. These observations are similar with the reports of Carvalho *et al.* (2015) in emu.

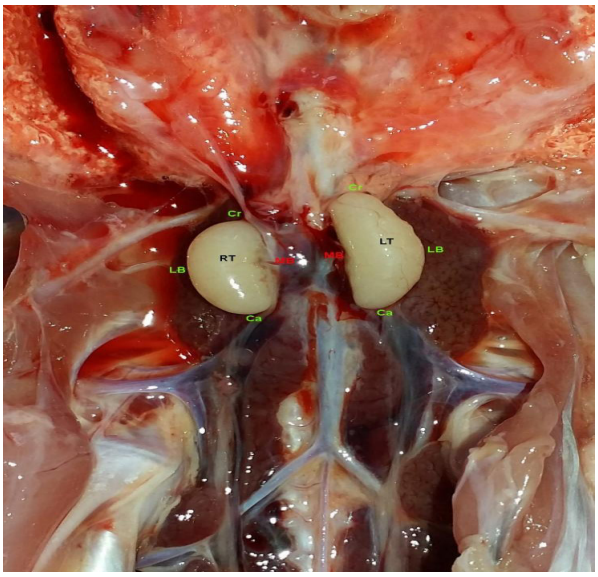

Fig. 3: Testis of 16 weeks old Guinea fowl. Right testis (RT), Left testis (LT), Cranial extremity (Cr), Caudal extremity (Ca), Medial Border (MB) and Lateral Border (LB).

Location

The testes of guinea fowl were placed symmetrically within the body cavity caudal to the respective lungs and adrenal glands on either side of the aorta and caudal venacava, in relation to respective kidneys, ventrally related to the proventriculus, liver and intestines. These observations are in accordance with the earlier findings in the ostrich and emu (Babic *et al.,* 2004; Elias *et al.,* 2007), in domestic fowl (Bull *et al.,* 2007) and in duck (Elbajory *et al*., 2013).

Age related changes regarding the location of testes revealed that, after hatching at day old, the testes and ductus deferens were indistinct and very difficult to demarcate. At two weeks of age, the lateral border was concave and medial border was convex in both the testis and at 8 weeks of age, the caudal extremity of left testis was directed more outwards than right testis and the testes was ventrally related with dorsal face of proventriculus. From 12 to 28 weeks of age, the medial border was concave and lateral border was convex in both the testes.

At 16 weeks of age, the cranial extremity of left testis was related with last rib. Caudal extremities of both the testes were located at the level of venous iliac externus which is a branch of posterior venacava. At 20 weeks of age, the left testis was situated more closely to median line than right testis. Caudal extremity of both testes was extended beyond the level of venous iliac externus. At this age, the spleen occupied a ventral position in relation to the left testis, while gizzard was lateral to it. These findings are like the report

of Bull *et al*. (2007) in domestic fowl. At 24 and 28 weeks of age, the spleen occupied the medial position and the gizzard was ventral to the left testis. From 24 weeks onwards abundant fat tissues were observed in and around the testes and associated regions (Fig. 4). The blood vessels on tunica albuginea became more evident as the age advanced and the vessels exposed a varied distributive pattern, running in different directions as reported by Bull *et al*. (2007).

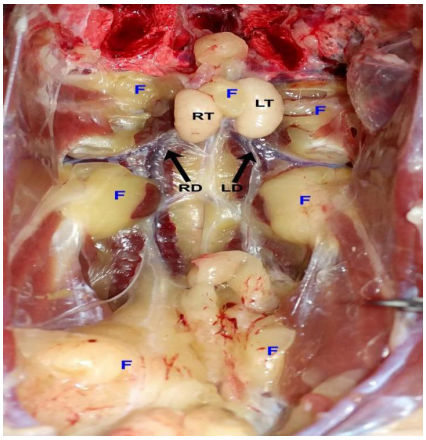

Fig. 4: Presence of abundant fat tissues in and around the male genital organs of 24 weeks old Guinea fowl. Left testis (LT), Right testis (RT), Right ductus deferens (RD), left ductus deferens (LD) and Fat tissues (F)

In present study, upto 8 weeks of age, both the testes appeared to be embedded on ventro-medial aspect of cranial lobe of respective kidneys. At 12 to 16 weeks of age both the testes grew out and were located ventral to cranial lobe of respective kidneys. Which further grown towards cranial-to-cranial lobe of respective kidneys from 20 and 28 weeks. It was contrary to the report of Bull *et al*. (2007) in domestic fowl, which stated that the testes displaced over cranial lobe of kidneys upto to 20 weeks of age, then from 21st weeks grow markedly, when they overlay on medial portion of kidneys.

Shape and Size

In day old keets, the testes were seen as thickenings on the upper parts of their respective ductus deferens as reported by Abdul-Rahman (2013) in guinea fowl. At 2 weeks of age both testes were almost equal, small rice sized and comma shaped, in which caudal extremity directed laterally. From 4 to 8 weeks of age, the testes were large rice sized and at 12 weeks of age, the right testis was short bean shaped but thicker and heavier than left testis, which was lengthier as stated by Chandrasekhara Rao (1994).

From 16 to 28 weeks of age, the left testis was heavier, lengthier, and elongated bean shaped than right testis as reported by Malecki *et al*. (1998) in emu. This was contrary to observations of Kannan *et al*. (2015) who stated that the right testis was found to be larger in length and lesser in width than the left testis in all the age groups of quails. This might be due to species variation. Cranial and caudal extremities of right and left testes were pointed at the age of 2 weeks, whereas from 4 to 8 weeks, the cranial extremity was slightly blunt than the caudal extremity. At 12 weeks, both extremities of testes were blunt followed by 16 weeks of age, when both the extremities of right testis were rounded, whereas cranial extremity of left testis was more rounded than caudal extremity. At 20 weeks of age, cranial extremity of both testes was more rounded than caudal. From 24 to 28 weeks, extremities of both testes were rounded in appearance (Fig. 2). These findings coincided with the observations in greater rhea (Carvalho *et al*., 2015).

Colour

From 2 to 12 weeks of age, the testes were yellowish white and more glistening, which became white to creamy white in colour from 16 to 28 Weeks of age. These observations akin to the reports of Abdul-Rahman (2013) in guinea fowl, Chandrasekhara Rao (1994) in drake and Kannan *et al*. (2015) in quail. But contradicted with Rajendranath *et al*. (2015) who stated that emu testis was dark green or black in colour. This might due to the species difference.

Morphometry of Testes

In guinea fowl, the testes of day old keets was very indistinct, the weight of right and left testis increased steadily from 2, 4 and 8 weeks of age. It showed rapid growth from 12 to 28 weeks till attainment of mature testes weight (Table 1). These findings are in accordance with Bull *et al*. (2007) who noticed that the right testis reached its maximum growth at 167 days, more precocious than the left one, with 210 days.

There was gradual increase in right and left testicular length from day old to 28 weeks of age, but significant increase ($p \leq 0.05$) was observed from day old to 2 weeks and 4 to 28 weeks of age (Table 1). These observations are in accordance with Bull *et al*. (2007) in domestic fowl, who noticed that the maximum length of both testes presented at 167 days and the beginning of decrease occurred at 359 days for the right testis and 353 days for the left one. The medio-lateral width of right and left testis significantly ($p \leq 0.05$) increased from day old to 28 weeks of age. The dorso-ventral width of right and left testis increased from 2 to 28 weeks of age, but significant increase ($p \leq 0.05$) was observed from 2 to 20 and 28 weeks of age (Table 1).

In the present study, the length and width of left testis was more, than right testis in all the age groups, which was in accordance with the findings of Faris (2015) in common quail, whose measurement of the length and width of right testes were 1.7±0.01 cm, 1.4±0.003 cm, while the average length and width of the left testes was 2.12±0.03 cm and 1.5±0.003 cm respectively**.** Kouatcho *et al*. (2015) stated that the testicular height and diameter significantly increased with age, unlike the left testis diameter that has been relatively higher than value of the right testis. The increase in these measurements was due to the increase in height and diameter of seminiferous tubules, as well as in Leydig cells number. In fact, during the prepubertal period, testicular development was highly correlated with the number and size of Sertoli cells, while during puberty, it correlated with germ cells.

Table 1: Gross morphometrical observations of testis in Guinea fowl at different age groups (Mean ± SE)

Parameters			Age groups of Guinea fowl								
			Measurements with Epididymis (upto 8 weeks)				Measurements without Epididymis				
			Day old	2 weeks	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks	28 weeks
Testis Weight (g)	R		-	$0.01^{a}\pm0.01$	$0.03^{a}\pm0.01$	$0.10^{b}\pm0.002$	$0.26^{c}\pm0.03$	$0.42^{d}\pm0.01$	$0.67^{e}\pm0.02$	$0.84^{f}\pm0.02$	$1.05^{g}\pm0.01$
	L		-	$0.01^{a}\pm0.00$	$0.04^{a}\pm0.00$	$0.13^{b}\pm0.01$	$0.39^{c}\pm0.02$	$0.61^{d}\pm0.08$	$0.79^{e}\pm0.03$	$0.94^{f}\pm0.02$	$1.19^{g}\pm0.02$
Length (mm)	R		$2.04^{a}\pm0.001$	$2.72^{b}\pm0.11$	$3.08^{b}\pm0.16$	$5.11^{c}\pm0.22$	$7.01^{d}\pm0.08$	$8.64^{e}\pm0.27$	$13.21^{f}\pm0.31$	$17.74^{g}\pm0.22$	$20.90^{h}\pm0.18$
	L		$2.61^{a}\pm0.01$	$3.67^{b}\pm0.09$	$4.66^{b}\pm0.11$	$6.51^{c}\pm0.15$	$8.49^{d}\pm0.14$	$10.07^{e}\pm0.35$	$16.82^{f}\pm0.25$	$22.33^{g}\pm0.61$	$24.17^{h}\pm0.07$
Width (mm)	M-L	R	$0.24^{a}\pm0.01$	$0.67^{b}\pm0.02$	$1.28^{c}\pm0.05$	$3.30^{d}\pm0.11$	$5.54^{e}\pm0.05$	$5.91^{f}\pm0.07$	$6.81^{g}\pm0.05$	$7.43^{h}\pm0.13$	$7.86^{i}\pm0.07$
		L	$0.21^{a}\pm0.01$	$0.53^{b}\pm0.04$	$0.90^{c}\pm0.02$	$3.12^{d}\pm0.19$	$5.07^{e}\pm0.05$	$6.01^{f}\pm0.19$	$7.22^{g}\pm0.16$	$7.89^{h}\pm0.06$	$8.11^{i}\pm0.07$
	D-V	R	-	$0.45^{a}\pm0.02$	$0.89^{b}\pm0.04$	$2.72^{c}\pm0.06$	$5.14^{d}\pm0.06$	$5.52^{e}\pm0.05$	$6.15^{f}\pm0.03$	$6.37^{f}\pm0.09$	$6.78^{g}\pm0.05$
		L	-	$0.41^{a}\pm0.03$	$0.72^{b}\pm0.04$	$2.45^{c}\pm0.08$	$5.41^{d}\pm0.06$	$5.76^{e}\pm0.08$	$6.29^{f}\pm0.19$	$6.14^{f}\pm0.05$	$6.93^{g}\pm0.13$
Volume (cm^3)	R		-	$0.01^{a}\pm0.01$	$0.07^{b}\pm0.004$	$0.12^{c}\pm0.003$	$0.32^{d}\pm0.09$	$0.49^{e}\pm0.01$	$0.77^{f}\pm0.17$	$0.97^{g}\pm0.07$	$1.11^{h}\pm0.04$
	L		-	$0.01^{a}\pm0.003$	$0.07^{b}\pm0.003$	$0.13^{c}\pm0.003$	$0.42^{d}\pm0.02$	$0.60^{e}\pm0.08$	$0.81^{f}\pm0.01$	$1.09^{g}\pm0.01$	$1.30^{h}\pm0.01$

*Means with different superscripts differ significantly ($P \leq 0.05$). R- Right, L- Left, M-L; Medio-lateral, D-V; Dorso-ventral.

Dyce *et al.* (2009) reported that testicles are relatively large (5 cm long) during the breeding season, while they shrink to about half that size during quiescent period. The volume of right and left testis increased significantly ($p \leq 0.05$) from 2 to 28 weeks of age (Table 1). These observations supported the findings of Faris (2015), who reported that the average right testicular size was 1.85±0.01 cm^3 and left testicular size was 2±0.04 cm^3 in adult quail.

The weight, length, width, and volume of guinea fowl testes increased as the age advanced till 28^{th} week of observation. These are in accordance with Gonza´Lez-Mora´N and Soria-Castro (2010), who stated that the length, width, and volume of the left testis follow a similar pattern, increasing from 8-day-old embryo to 28-week-old bird, with the maximal increase in the last stage in *Gallus domesticus***.**

Kouatcho *et al*. (2015) reported that the weight and testicular volume normally increase with age until puberty in Coturnix quail. The basis for testicular unevenness remains unknown, but may be due to unequal number of primordial germ cells built-in into the embryonic gonad (Noirault *et al.*, 2006). Deviche *et al.* (2011) reported that this asymmetry in growth seems to be likely due to low sensitivity of the least developed testis to gonado-stimulating factors. However, cellular basis of this potential difference has not yet been investigated. Kigir *et al*. (2010) reported increase in the weight and size of the testes with increased age in pigeon.

Conclusion

The testes of guinea fowl were covered by peritoneum, placed symmetrically within the body cavity caudal to respective lungs on either side of median line. The right testis was thicker and heavier at the age of 12 weeks, later left testis was thicker and heavier till 28 weeks of age. Upto 12 weeks of age, the testes were yellowish white glistening in appearance, and thereafter white to creamy white in colour. The weight, length, width, and volume of each testes increased as the age advanced till 28 weeks of observation.

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