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The effect of the daylight length on mass and vascularization of the quail (Coturnix coturnix japonica): an experimental study

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ABSTRACT

A number of 24 Japanese quails were divided into two groups in order to observe changes in vascularization and weight of the testes during the reproductive and quiescent periods. Group1 was exposed to a long photoperiod of (Light, Dark) 20hL:4hD (20 hour Light:4hour Light) at 18-24°C while the Group 2 received a short photoperiod of 7hL:17hD at 8-12°C. The blood vessels were filled with colored latex for examination. The results revealed that each testis was mostly nourished by a single testicular artery which was arising solely from the descending aorta. The simple nature of the vessels in the quiescent period became very complex as the testes enlarged in the reproductive stage. Weights of the testes between the groups indicated the fact that the left testis was significantly larger during the reproductive and quiescent sexual periods. Consequently, our study showed that long photoperiods and temperatures significantly affect the vascular development of the testes as it is in the reproductive development.

Key words: Daylight, Japanese quail, Photoperiod, Testis, Vascularization.

INTRODUCTION

Blood flow of the testes in avian species is less complex in comparison with testes in mammals. Since the testes, particularly those whose reproductive activity follows a strict rhythm adjusted to seasonal conditions, show periodic variations in size and weight concomitant with reproductive cycles and the vascular structures of testes naturally increase to supply adequate nourishment (Kurtul I, 2002). This is especially observed in wild birds (i.e. size is 1:300 between the reproductive and quiescent periods) as well as photoperiodically-induced domestic animals (King *et al*., 1997; Satterlee and Marin, 2004).

The significant effect of the photoperiod on testicular function is well known in birds. Increasing the clear and red day light has been shown to have profound affirmative effect on testicular function (King *et al*., 1997; Harisson *et al*, 1970; Chaturvedi et al, 2006). Furthermore, studies on Angola roosters (Reviers and Roosen-Runge, 1977) and Japanese quails (Satterlee and Marin, 2004) have shown that using longer day light (for example, LD, 14:10) leads to the early testicular development while 7 h of daily light (LD, 6:18) deteriorates this development.

Increasing interest in the quail species as models for experimental researches including on gonadal functions (Satterlee and Marin, 2004, Chaturvedi *et al*, 2006; Hazard *et al*., 2005; Chaturvedi and Kumar, 2007) leads veterinary anatomists to focus on the modifications observed in the morphology of these species, hereby the morphology of testes during the reproductive and quiescent periods. Therefore, this study was performed to clarify the alterations occurring in the gross morphology of the testicular structures of the Japanese quail, particularly vascularization and weight during the reproductive and quiescent periods. Thus, the findings might be a valuable contribution to functional anatomy literature of avian species.

MATERIALS AND METHODS

A number of 24 mature male Japanese quails were divided equally into two groups. The first group (Group 1) was exposed to a long photoperiod of 20L:4D at 18-24°C for 3 months, beginning with August while the second group (Group 2) received a short photoperiod of 7L:17D at 8-12°C for 3 months, beginning with November, as suggested in a study (Brilard and Reviers, 1981). All animals received feed and water, *ad libitum*.

The animals of the Group 1 were anaesthetized by the use of ketamin hydrochloride (60 mg/kg), as suggested in a study (Flecknell, 1982) upon taking the X-rays of the testes. The vessel systems were then washed through the aorta using 0.9% salt water, and red colored-latex (ZPK-582-G by Educational & Scientific Products Ltd, Rustington, West Sussex) was injected by the way of the aorta under constant pressure while blue colored-latex was administered through efferent renal vein (Hassa, 1967).They were later put in water in order to set the latex for 48 hour, and were kept in 10% formaldehyde to protect from decay. Finally, the vessels of the testes were dissected and observed.

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Nomina Anatomica Avium (1993) was used for the anatomical nomenclature.

The statistical analysis was performed by using parametric techniques including independent and paired Student-t test and correlation.

Since the number of animals used in the study was 24 (n<30), the Student-t test was performed. Thereby, One-Sample Kolmogorov-Smirnov Test was used to determine whether the data was normally distributed. The sign value of the weight in the Group 1 was 0.867 (0,867>0,05). It was 0.952 (0,952>0,052)in the right testes and it was 0.853 (0,853>0,05) in the left testes of the Group 1. Likewise, the sign value of the weight in the Group 2 was 0.619 (0,619>0,05), it was 0.100 (0,100>0,05)in the right testes and it was 0.120 (0,120>0,05) in the left testes of the Group 2. All the values presented showed normal distribution. Results of the Student-t test were assessed by considering F distribution values by using the SPSS statistic program (SPSS 12.0, Chicago).

RESULTS AND DICUSSION

The right testis was supplied by a single testicular artery (Figs. 1/2; 3/2) originating solely from the descending aorta while the left testis received blood via a single testicular artery (Figs. 1/2; 3/2) observed in the 9 models and via two testicular arteries observed in the 3 cadavers.

The sole right testicular artery in the Group 1 arose from the right aspect of the descending aorta and 1.5 cm far from the origin of the celiac artery. It made a curl as approaching the right testis. Then, 2.5-3 cm later, it divided into 2 main branches in the 8, and 3 main branches in the 4 cadavers. These branches entered the right testicular tissue through the medial aspect and it nourished the related areas via several smaller thin branches. The left testicular artery in the Group 1 separated from the descending aorta exactly from the opposite side of the right testicle, and it was longer than the one located on the left testicle. The 0.2-0.4 cm later, it had 3 main branches observed in the 9, and 2 branches observed in the 3 cadavers. As in the right side, the branches of the left testicular artery entered the left testicular tissue through the medial aspect and it vascularized the related areas via several smaller thin branches (Table 1).

Totally 3 testicular veins arose from each testis in the Group 1 (Fig. 2/2). The vessels of the left testicle were longer. Each vessel drained the related parts of the testis, and separately joined the caudal vena cava.

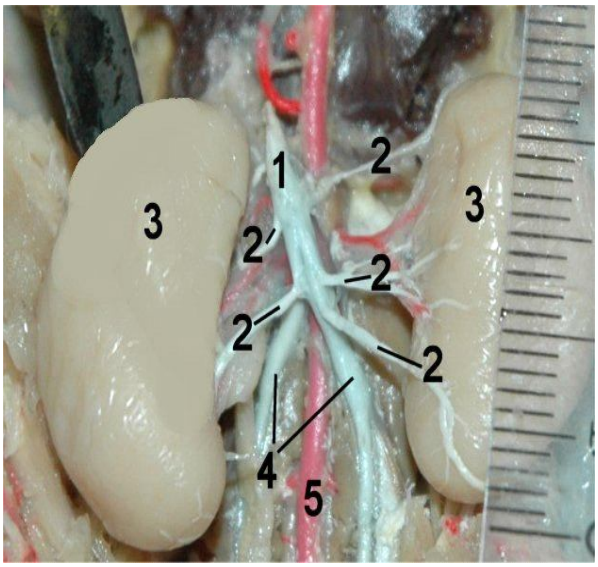

Fig 2: Veins of the testes in the Group 1 (Reproductively active bird), ventral view. 1. Caudal vena cava, 2. Testicular veins, 3. Testes, 4. Right and left common iliac veins, 5. Descending aorta.

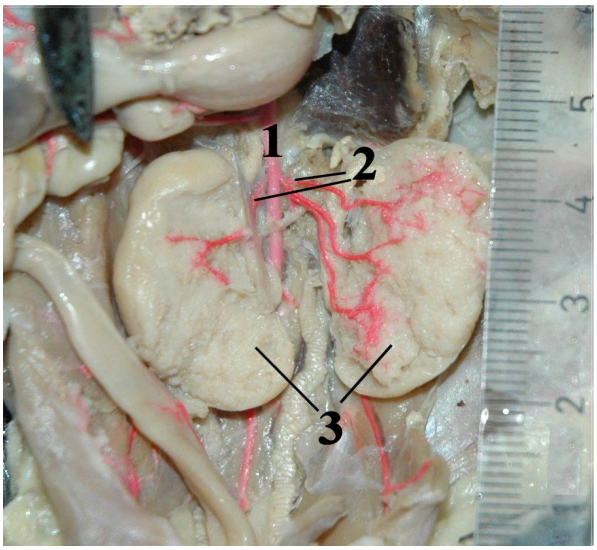

Fig 1: Arterial vascularization of the testes in the Group 1 (Reproductively active bird), ventral view (Partially dissected testes) 1.Descending aorta, 2. Testicular arteries, 3. Testes.

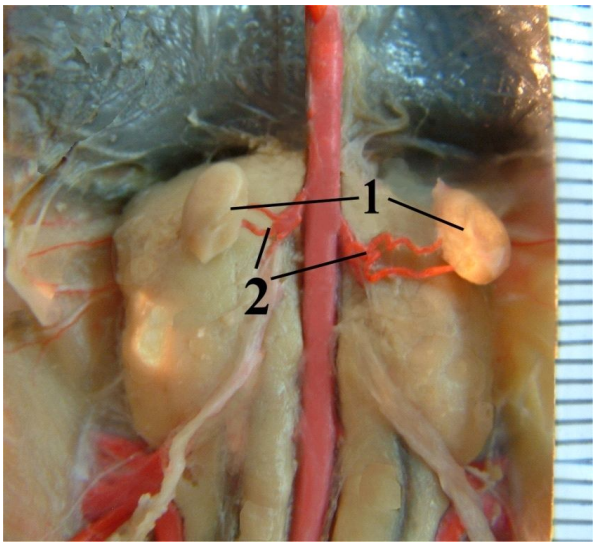

Fig 3: Arterial vascularization of the testes in the Group 2 (Reproductively inactive bird), ventral view. Testes, 2. Testicular arteries, 3.Renes

Table 1: Weights of the body, and right and left testes in Group 1 (Reproductively active birds)

Animals	Body weight, g	Right testes, weight, g	Left testes, weight, g
1	122.70	1.92	2.24
2	96.65	0.67	0.80
3	141.11	1.82	2.42
4	152.65	1.75	1.85
5	192.62	2.14	2.18
6	187.85	2.04	2.23
7	98.88	1.68	2.02
8	95.27	1.14	1.22
9	144.32	2.88	3.13
10	212.23	3.12	3.49
11	185.33	2.24	2.35
12	102.30	0.96	1.47

Since the testes of the Group 2 were extremely small as compared to those of the Group 1, likewise, their arteries and veins were seen as simple. Even though the testes resembled to those of the active stage (i.e. their number, pattern and distribution in the Group 2 were similar to those in the Group 1), they were very thin and small.

The paired samples of the right and left testes (Group 1) were compared to each other by using Student-t test and the significance value was 0.000 ($p=0.000<0.05$). These results clearly indicated that there was a significant weight difference in-between. In fact, the mean weights were 1.8633±0.7184 g in the right testes and the mean weights were 2.1167±0.7463 g in the left testes, with a 95% confidence interval.

A positive and high correlation was present between the body weight and the weights of the right and left testes of the Group 1 (at 1% sign level, $r = 0.776$, and at 5% sign level, $r = 0.704$, respectively). Moreover, a positive and very high correlation was determined between the weights of the right and left testes ($r = 0.971$).

The paired samples of the right and left testes (Group 2) were compared to each other by using Student-t test and the significance value was 0.008 ($p = 0.008<0.05$). These results clearly indicated that there was a significant weight difference in-between. The mean weight of the right testes in this group was 0.2967±0.3425 g while the mean weight of the left one was 0.3500±0.3953 g, at a 95% confidence interval.

There was a positive but average correlation between the body weight and the weights of the right and left testes of the Group 2 $r = 0.434$ and $r = 0.437$, respectively) (Table 2). However, the correlation was positive and very high between the weights of the right and left testes ($r = 0.998$).

According to the Student-t test performed for the independent samples, the significance value of the body weights was 0.005 (sign = 0.005<0.05) between the groups which indicated that there was a significant difference. The mean body weights of the Group 1 and 2 were 143.8333±42.2112 g and 188.5000±22.1462 g, respectively, with a 95% confidence interval.

According to the comparison results of independent samples performed by Student-t test, the weight of the right testes of either active or inactive quails was significantly different in-between group ($p = 0.000<0.05$). The mean testicular weights were 1.8633±0.7184 g and 0.2967±0.3425 g, respectively, at a 95% confidence interval.

Student-t test results of the independent samples showed that the significance value of the mean weights of the left testes was 0.000 ($p = 0.000<0.05$) which indicated that there was a significant difference between the groups. The mean testicular weights were 2.1167±0.7463 g and 0.3500±0.3953 g, respectively, with a 95% confidence interval. Thus, there was a negative and weak correlation between the mean body weight in the active and inactive quails ($r = -0.426$), there was a negative and moderate correlation between the mean weight of the active quails and the inactive right testes ($r = -0.640$), and inactive left testes ($r = -0.658$).

It has been indicated that the size and functional natures of avian testes depend mostly on the structural and ecological factors. For example, testicular sizes of the animals fed together are indeed larger than those of the species fed alone. Hence, feeding rate and food quality enlarge the testicular size (Dunn *et al*., 2001, Pitcher *et al*., 2005). Yet, another study has clearly documented the apparent reverse affects of the daily light on the testicular development in Angola roosters (Reviers and Roosen-Runge, 1977). Photoperiod and chemical manipulations performed in this study have also similar effects on the gonadal growth and functional induction in the young and mature animals,respectively (Satterlee and Marin, 2004; Flecknell, 1982; Brilard and Reviers, 1981).Our study has also indicated the longer and shorter light effects on the gross testicular morphology of the Japanese quails; particularly on size and vascularization.

Table 2: Weights of the body, and right and left testes in Group 2 (Reproductively inactive bird)

Animals	Body weight, g	Right testes, weight, g	Left testes, weight, g
1	182.34	0.03	0.04
2	187.87	0.67	0.83
3	239.76	0.44	0.51
4	180.54	0.12	0.17
5	176.25	0.05	0.07
6	164.79	0.13	0.15
7	195.44	0.07	0.09
8	223.11	0.85	0.99
9	172.07	0.08	0.11
10	169.84	0.05	0.04
11	194.81	0.11	0.12
12	180.60	0.96	1.08

The study was performed during a period of August-October for the Group 1 in order to maximally utilize both the environmental and seasonal properties (i.e., a long photoperiod of 20hL:4hD at 18-24°C). The time period is when the animals become sexually active. Similarly, in order to help the testes become photorefractory, the animals of the Group 2 were included in the study between November and January when there was a short photoperiod of 7hL:17hD at 8-12°C.

In this study, structural patterns of the arterial and venous vessels in the testes of the Japanese quails that can be seen both in the reproductive and quiescent periods were observed. As expected, the simple nature of the vessels in the quiescent period became very complex as the testes enlarged in the reproductive period in order to sufficiently nourish testicular tissue.

The veins of the testes in the Group 2 were not detaily observed since they were so small.

In our study, there was a significant difference between the mean body weights of the two groups. This is because of the fact that animals of both groups were at the same age. The animals of the Group 1 were exsanguinated in the end of the October whereas the ones in the Group 2 continued to be grown under the same conditions for another three more months. There were positive and high correlations between the weights of the right and left testes in the Group 1 (r = 0.776) and Group 2 (r = 0.971); respectively.

It is well known that the right testicle in birds never reaches the size of the left one. Even though both are functional, the right testicle is bigger than the left one during the reproductive period. Additionally, we have also determined that there were significant weight differences between the right and left testes of the Group 1 and Group 2. The mean weights of the right and left testes in the Group 1 and Group 2 were 1.8633±0.7184 g and 2.1167±0.7463 g, and 0.2967±0.3425 g and 0.3500±0.3953 g, respectively. These findings apparently have indicated the fact that it is also true during the both reproductive and quiescent sexual periods.

Testes of the avian species display periodic differences in size and weight according to the reproductive cycles. This is particularly common in wild birds and photoperiodically-induced species (King *et al*.,1997; Satterlee and Marin, 2004). The size and weight ratio between the reproductive and quiescent periods might reach up to 1:300. Our study has revealed a statistically significant difference between the mean testicular weights of the Group 1 and Group 2. However, these significant differences were determined to be nearly 10-fold between the right testicular weights while it was 7-fold between the left testicular weights. These values were low as compared to the testes of the wild birds. This big difference is seen particularly in wild birds that have a following a strict rhythm in their reproductive adjusted to seasonal conditions.

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