Histological Development of the Paracloacal Vascular Body in the Male Embryo of Muscovy Duck, Cairina moschata

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The histological development of the paracloacal vascular body was observed in the male embryo of muscovy duck. On the 14th day of incubation, the primordium of the paracloacal vascular body was first recognized as an oval mass of mesenchymal cells containing a few blood capillaries and which lay lateral to the urodeum. The well-developed blood vascular system as well as the arterioles and venules was distinguished on the 16th day. The capillary cord and the peripheral lymphatic space partly appeared on the 18th day. After this stage the peripheral lymphatic space was gradually formed around the whole parenchyma of the body, and the internal lymphatic space, the trabecula and the capsule were also developed simultaneously. All of the main components of the paracloacal vascular body thus appeared by the 24th day of incubation. On the other hand, the lymphatic space of the fibrolymphatic body occurred from the peripheral lymphatic space of the paracloacal vascular body on the 19th day. Typical reticular lymphatic spaces were formed in the fibrolymphatic body on the 24th day.—Key words: Embryo, Muscovy duck, Paracloacal vascular body.


The avian phallus is divided into two main types—an intermittent type (phallus protrudens) observed in the ratite, tinamou and anseriform, and a non-intermittent type (phallus nonprotrudens) in the galliform species [4, 5, 7, 8, 9, 11] and in anseriforms [3, 7, 8]. The components of the paracloacal vascular body consist chiefly of a capsule, trabeculae, capillary cords, peripheral and internal lymphatic spaces [2, 6, 9, 11]. Concerning its morphogenesis, there is only Yamano’s study using the male chick embryo [12]. In the present study, the histological development of the paracloacal vascular body is examined using the male embryo of muscovy duck, of which the type of phallus is different from that of the galliform.

MATERIALS AND METHODS

Eggs were taken from muscovy ducks kept as a closed colony in our laboratory after purchase from Tokyo Livestock Experiment Station. These fertile eggs were incubated at about 37.5°C and 80% humidity. The cloacal tissues including the phallus were excised from 51 male embryos covering the period
from the 14th day of incubation to the hatch (the 34th day). These cloacal tissues were fixed in Bouin solution, dehydrated with a graded series of ethanol and embedded in paraffin. The serial transverse sections of 5–8μm thick were prepared perpendicularly to the shaft of the phallus, and then stained with hematoxylin and eosin or Azan variant.

RESULTS

On the 14th day of incubation, the primordium of the paracloacal vascular body was observed as an oval mass of mesenchymal cells without remarkable demarcation (Fig. 1). The primordium containing a few blood capillaries was situated lateral to the urodeum between the cloacal sphincter muscle and the internal pudendal artery (Fig. 2).

The increases of the primordium in size and cellular density (Fig. 3) and the blood capillaries in number (Fig. 4) were observed in the 16-day-old embryo. The internal pudendal artery was accompanied by a few nerves and the internal pudendal vein at the hilus of the paracloacal vascular body [6].

On the 18th day, many narrow lymphatic

**Fig. 1.** Primordium of the paracloacal vascular body (arrow) on the 14th day of incubation. Azan stain. ×40. U: urodeum

**Fig. 2.** On the 14th day. Primordium containing a few blood capillaries (arrow). Azan stain. ×200. A: internal pudendal artery, M: cloacal sphincter muscle, Pm: primordium.

**Fig. 3.** On the 16th day of incubation. H&E stain. ×40. U: urodeum.

**Fig. 4.** On the 16th day. Blood capillaries increased. One of the blood capillaries (arrow) flows into the internal pudendal vein. Azan stain. ×200. A: internal pudendal artery, Pm: primordium, V: internal pudendal vein.
spaces were situated on the dorsal fringe of the parenchyma of primordium, and a few protrusions of the lymphatic space were also observed in the parenchyma (Fig. 5). The increase in the cellular density of primordium made its border clear. In the transverse sections, the primordium of the paracloacal vascular body tapered off to a point at the ventral side (Fig. 6). Many blood capillaries in the primordium partly formed the capillary cord [6] (Fig. 5).

On the 20th day, the primordium accompanied with the internal pudendal artery gradually decreased in size stretching to the base
of pallus. Near the base of phallus the broad peripheral lymphatic space with a few trabeculae was observed in the primordium. At the level of the urodeum, the peripheral lymphatic space developed not only on the dorsal side of primordium but on its ventrolateral side and near the hilus (Figs. 7 and 8). Facing the peripheral lymphatic space, the deep invagination of the parenchyma was frequently observed. The capsule layer was clearly identified on the dorsal side of the peripheral lymphatic space (Fig. 7).

The peripheral lymphatic space containing a few trabeculae was formed almost all around the parenchyma except at the hilus in the 22-day-old embryo. The cellular density became much higher, and the internal lymphatic space increased in both size and number in the parenchyma (Figs. 9 and 10). On the ventral side of primordium, both sides of peripheral lymphatic space approached to join with each other.

On the 24th day, the peripheral lymphatic space became broader than that of the 22-day-old embryo, and the trabeculae connecting the parenchyma with the capsule were formed almost entirely (Fig. 11). The essential components of the paracoalcal vascular body [6] were established in this stage. After this stage the paracoalcal vascular body gradually increased in size and in the complexity of the
histological architecture.

On the other hand, the lymphatic space resulting from extention of the peripheral lymphatic space of the paracloacal vascular body was also observed in the basal fibrolymphatic body of phallus on the 19th day of incubation. This lymphatic space was situated around the internal pudendal artery, and extended to half of the total length of phallus to form the reticular lymphatic space in the basal part of phallus at the stage of 20 days of incubation. After this stage the well-developed reticular lymphatic space reached the tip of phallus and finally the basic structure of the lymphatic system in the paracloacal vascular body and fibrolymphatic body was completed on the 24th day.

DISCUSSION

According to an accurate observation by Liebe [7], the phallus of the domestic duck is composed of paired basal and spiral fibrolymphatic bodies, a spiral ejaculatory groove, a glandular tube, a trabecular space, a cord-like elastic body and paired vascular bodies. Although the paracloacal vascular body is the essential organ of these components, there is little knowledge of its histological development in the avian embryo except the male chick embryo reported by Yamano [12].

In the present study, it was elucidated that the paracloacal vascular body of the muscovy duck developed in order of the following steps: (1) Accumulation of the mesenchymal cells. (2) Formation of many blood capillaries. (3) Appearance of the peripheral lymphatic space and the capillary cord. (4) Development of the peripheral lymphatic space accompanied with formation of the internal lymphatic space, trabecula and capsule. The term of "capillary cord" (Kudo et al. [6] and Sugimura et al. [11]) in this paper is equivalent to "capillary tuft" or "glomerus" named by Knight (Ph. D. Thesis, Michigan State University) who described that the small tertiary rami arising from the secondary rami of the phallic and terminal pudendal arteries formed the glomus between the ramifications of the afferent tertiary artery and the efferent tertiary vein. However, the architecture of the capillary cord is not confirmed in the present study. The three-dementional structure of the capillary cord may be clarified by the application of scanning electron microscopy for its plastic cast.

The results obtained from this study are almost coincident with those of the chick embryo reported by Yamano [12]. Especially, the fact that development of the lymphatic space of the fibrolymphatic body resulted from the extention of the peripheral lymphatic space of the paracloacal vascular body is significance in relation to phylogenesis of a corpus cavernosum penis and a corpus spongiosum penis. Phylogenetically the corpus cavernosum penis occurs before the appearance of the corpus spongiosum penis; namely, in the monotreme, the corpus cavernosum penis is present but the corpus spongiosum penis is absent, while both are present in the marsupial as in the other higher mammals [10]. Yamano [12] assumed that the paracloacal vascular body was probably homologous with the corpus cavernosum penis, since the beginning of its formation was indicated by accumulation of the mesenchymal cells accompanied with the blood vessels. On the other hand, according to the view of Gerhardt [1], the fibrovascular bodies of chelonians are homologous with the corpus cavernosum penis of mammals so that the corpus cavernosum penis seems to be homologous with the fibrolymphatic bodies of the anseriform, but not with its paracloacal vascular bodies.

For the further discussion about the phylogenesis of fibrolymphatic bodies of the anseriform, it is required to extend this study to the histogenesis of the paracloacal vascular bodies and fibrolymphatic bodies of many other avian species including the ratite.
REFERENCES


要 約

バリケン排泄腔の排便管の組織発生学的研究：藤村久子・西田隆雄・佐々木博之1）他

1）日本電子製造株式会社EM応用研究室）——挿入型のファーラスを

もつバリケン雄の在について排泄腔排便管の組織発生を観察し、以下の結果を得た。排泄腔排便管

は少量の毛細血管を含む間葉細胞の集合として、卵殻14日に見られる両側に認められた。卵殻16日には

小動・静脈を含めて血管系がよく発達し、卵殻18日に毛細血管系および周辺リッパ腔が部分的に出現し

た。以後、管状体実質の全周にわたって周縁リッパ腔が徐々に形成され、同時に内リッパ腔、柱および

被膜も発達し、卵殻24日までに排泄腔排便管の一部がを構成単位が出現した。これらの所見は

ニワトリの場合と同様であった。一方、線維リッパ体のリッパ腔は排泄腔排便管の周縁リッパ腔から

卵殻19日に派生し、卵殻24日には線維リッパ体中に網状のリッパ腔を形成した。

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