TEM and SEM Investigations of Lymph Hearts in Birds*

D. Berens v. Rautenfeld, K.-D. Budras
Department of Veterinary Anatomy, Histology, and Embryology of the Freie Universität Berlin, Koserstraße 20, D-1000 Berlin 33

Summary

The fine structure of lymph hearts in birds is described. These organs could be made visible by application of marker medium and indirect and direct injection of contrast medium. As two special morphologic features we note strange modified skeletal muscle cells in the wall of the lymph hearts and efferent collectors to the epidural spinal lymphovenous sinus. The lymph hearts possess valves that regulate the passage of lymph from the lymphatic copulatory organ and the thoracic duct into the venous blood system.

Introduction

Lymph hearts occur in different number in amphibia (4). Generally, reptiles (5) and birds just possess only one pair of caudal lymph hearts. Our investigations deal with lymph hearts of juvenile and adult aves (ducks, swans, emus, rheas).

Results

Avian lymph hearts (ALH) are located upon the transversal processuses of the synsacrum. Nearly all efferent and afferent collectors of the lymph hearts are passing the foramina intertransversaria.

Avian lymph hearts are either totally or partly covered by the caudal levator muscle. The lumen of the ALH is sporadically septated and crossed by trabeculae (Fig. 1, above). The wall of the ALH is composed of an endothelial interna, a muscular media, and an externa that consists of plurivacular white fat cells.

The media has — like the wall of the collector — an inner layer of smooth muscle cells (Fig. 1 below) and an outer layer of so-called striated lymph heart muscle cells (Fig. 1, insert). The outer layer is relatively thick in struthioniform thinner in swans, and even thinner in ducks. The lymph heart muscle cells crisscross and insert at the synsacrum and the first three caudal vertebrae. They also pass through the trabeculae and septa and show similarities with the mammalian skeletal and heart muscle cells. Multi-nuclear muscle cells are relatively short and sporadically ramified, and have short bundles of filaments. The broad-flattened endings of cells get in contact by end-to-end nexus. Besides these lymph heart muscle cells, there are lightly coloured, filament-poor cells, that show striking similarity with the bundle of His. The musculature of the lymph hearts is innervated by non-medullated synsacral nerves and possesses numerous satellite cells.

The adventitia of the ALH is predominantly formed by white, plurivacular fat cells (Fig. 2, above) that serve as pressure pads (3).

The investigation of afferent and efferent lymph heart collectors was performed by injecting India-ink, Berlin-blue, Latex, and contrast medium like Lipiodol® and Iotasul® (Schering AG, Berlin/Bergkamen).

Caudal afferent collectors transport the lymph fluid from the lymphatic copulatory organ to the lymph hearts (Fig. 2, below). According to previous investigations the copulatory organ is erected by lymph that transudes into the so-called lymphobulbus (2). It is passed on into the lymph sinuses of the phallus, thus
Fig. 1 Legend see page 189

Permission granted for single print for individual use.
Reproduction not permitted without permission of Journal LYMPHOLOGY.
Fig. 2 Legend see page 189

Permission granted for single print for individual use.
Reproduction not permitted without permission of Journal LYMPHOLOGY.
Besides these collectors, there is one ventral branch to the internal iliac vein and a dorsal branch to the epidural spinal lymphovenous sinus. This sinus and the dorsal branch can be filled with marker medium injected into the spatiun interarcuale sacrococcygeum.

The passage of lymph in all these afferent and efferent collectors in the AHL is regulated by valves.

Discussion

Finally, we wish to accentuate the following special features of the ALH:

1) In the wall of the lymph hearts we note a special muscle tissue that can be considered lymph heart muscle cells. These striated muscle cells represent early, however, retarded, myogenetic stages, so that no continuous syncytium is formed in the subadult and adult birds. The cells, however, exhibit a contractility in ducks and emus, while in some other birds they show already signs of degeneration.

2) As known from mammals, birds possess in addition to the cranial lymphovenous anastomosis near the pre-caval vein, a caudal anastomosis near the lymph heart area. In drakes and strutthioniforms, at least 10 ml lymph fluid flows after each erection from the lymphatic copulatory organ into the blood system within 15 minutes. Post-ejaculation, the transport of lymph to the lymph heart is promoted by rhythmic movements of animal’s tail. In contrast to the drake, the lymph hearts in the male chicken have degenerated by onset of sexual maturity. In this species, the greater portion of the lymph flows while mating from the lymphatic copulatory organ into the internal iliac vein and a dorsal branch to the epidural spinal lymphovenous sinus. This sinus and the dorsal branch can be filled with marker medium injected into the spariun interarcuale sacrococcygeum.

The passage of lymph in all these afferent and efferent collectors in the AHL is regulated by valves.

Discussion

Finally, we wish to accentuate the following special features of the ALH:
through the epithelium of the lymph folds into the cloacal lumen (1). This lymph portion (transparent fluid) constitutes the final fraction of the ejaculate.

3) Anastomoses between the lymph hearts on the one hand and the epidural spinal lymphovenous sinuses on the other hand, represent a drainage system not yet mentioned in literature.

References

1 Berens v. Rautenfeld, D., K.-D. Budras, and Renate Gassmann: A morphological study of antibody transport in the transparent fluid flowing from the lymph folds of the copulatory organ into the cloacal lumen of the cock (Gallus domesticus). Z. mikrosk.-anat. Forsch. 90 (1976) 989–1008
4 Kampmeier, O.F.: On the lymphatic system of Ascaphus; its evolutionary significance. Anat. Rec. 132 (1958) 343

Prof. Dr. D. Berens v. Rautenfeld, Institut für Veterinär-Anatomie, -Histologie und -Embryologie, Freie Universität Berlin, Koserstraße 20, D-1000 Berlin 33

Volume covers

Blue cloth with stamping for volume 14 (1981) will be available in February 1982 at DM 17,80. Please order at your local bookstore.

To our readers

The cost of producing our journal rose again last year, and so unfortunately we are forced to readjust the price of “Lymphology” as from January 1, 1982. The annual subscription rate will be DM 124,— plus postage inland DM 4,96 abroad DM 6,80, single copies DM 40,80 plus postage from place of publication.