Introduction

There have been only a few reports concerning the morphology of the lymph nodes of elephants. Segerstad (1927) observed the lymph nodes in an infant Indian elephant rather long ago, and since then two other reports have described those in Indian and African elephants, respectively.

These previous works seem to be fragmentary and insufficient and some of them have led some readers to assume that the lymph nodes of the elephant would resemble those of the pig, the so-called "the reverse type". Aijima et al. and Suzawa et al. studied the postnatal development of the lymph nodes in relatively large animals, such as cattle and dogs. These animals' lymph nodes are known to possess a well-developed system of trabeculae, and show afferent lymphatic vessels that ramify into numerous branches which either open into the subcapsular sinus or penetrate trabeculae and open into the intermediate sinuses. The cortical lymphoid tissue broadly extended under the capsule and along the trabeculae containing lymphatic branches. The medulla was made up of the medullary cords and sinuses, and was interlaced by coarse networks of medullary trabeculae. These results indicate that the elephant lymph node is rather more comparable to those of bovines and canines.

Key words: lymph node, elephant, histology, trabecular system, afferent lymphatic vessel

Materials and Methods

One each of the inguinal and cervical lymph nodes were obtained from a female African elephant (estimated age of 25 years) after about 24 hours of death (The cause of death being currently examined pathologically). These materials were fixed in a solution of 10% neutral buffered formalin, embedded in paraffin and sectioned serially at a thickness of 4–6 μm. They were stained with Hematoxylin-Eosin, May-Grünwald & Giemsa solutions and silver impregnation.

Results

Overview

Macroscopically, the lymph nodes were large and roughly ovoid in outline. An example of a cervical lymph
node is shown in Fig. 1 (Max ca. 45 mm × 15 mm).

There was no recognizable difference in histology between the cervical and inguinal lymph nodes. They possessed a well-developed trabecular system and their parenchyma were composed of a number of lymphoid segments, which were referred to as “nodal compartments (segments)”. The compartments were mostly semi-rounded in outline and arranged side by side under the capsule (Fig. 2). The nodes received a number of afferent lymph vessels at their convex surface, and the nodal compartments were associated with each afferent vessel. The interior of the compartments consisted of the cortex, located in the outer half, and the medulla, occupying the inner half. Efferent lymph tributaries arose from the innermost aspects of the compartments and ran towards the hilus, where they were collected into a couple of efferent lymph vessels.

Trabeculae and afferent lymphatic distribution in the node

At each nodal compartment, the capsule gave rise to a couple of large trabeculae extending inside the parenchyma. They each underwent repetitive division and produced a number of secondary and tertiary trabeculae among the cortical mass. Since these large and branching trabeculae were accompanied in parallel manner with a fold consisting of both the intermediate sinus and cortical lymphoid tissue, we can call ‘cortical trabeculae’.

After entering the node at the regions of supply, afferent lymph vessels generally divided into several afferent branches within the capsule. Some afferent branches ran within the capsule and sent off numerous small twigs to open into the nearby subcapsular sinus at multiple sites (Fig. 3). The remainder of the afferent branches penetrated into the large trabeculae and underwent repetitive division, so that all cortical trabeculae branching from the large trabeculae were supplied with afferent lymph branches. On their way passing through the cortical trabeculae, afferent branches sent off smaller afferent twigs one after another that opened into the nearby intermediate sinuses at various depths.

Cortex (cortical lymphoid tissue) and its distribution

The cortex not only extended beneath the capsule, but also followed along those cortical trabeculae which were penetrated by afferent lymphatic branches (Figs. 3, 4). The cortex appeared to be constituted from two layers, that is, an outer layer of peripheral cortex and an inner layer of deep cortex. The lymph follicles containing germinal centers were frequently seen in various locations in the peripheral cortex layer (Fig 5). The deep cortex layer was characterized by exhibiting many profiles of high endothelial venules (HEVs). This layer was mostly continuous and tended to show considerable bulging towards the medulla in association with locations where the afferent lymph branches opened into the overlying subcapsular or intermediate sinuses.

Rarely, afferent lymphatic branches running within the capsule or cortical trabeculae happened to open singly into the lymphatic sinus some distance apart from the other openings. In such cases, we recognized that the deep cortex formed a semi-spherical structure which was contiguous to the peripheral cortex and bulging towards the medulla. This type of structure seemed to us to correspond to “the unit-structures of the deep cortex”, which we described previously in our observations on the bovine and canine lymph nodes.

Medulla

The medulla was made up of the medullary cords and medullary sinuses, and both of the components were tor-
Histological findings of elephant lymph node

In addition, medullary trabeculae, which arose in the form of continuations of the cortical trabeculae at the cortico-medullary junction, interlaced among the medullary mass.

Efferent lymph tributaries arose from the nodal compartments at their innermost aspects, ran within band-like (hilar) connective tissues and were collected (converged) into a couple of efferent lymph vessels at the hilus.

**Discussion**

The present study was undertaken with the primary concern of clarifying whether the structure of the elephant lymph nodes belongs to the unusual type seen in the pig or the ordinary type, by observing the lymph nodes of an African elephant.

Major findings on the histological architecture of the elephant lymph nodes are summarized as follows: (1) Parenchyma was divided into several segments; (2) The afferent lymphatic vessel entering a segmented cortical parenchyma ended up with numerous openings to the subcapsular and intermediate sinuses. However, they never existed in the medulla; (3) The cortical lymphoid tissue, consisting of the peripheral and deep cortices, extended broadly beneath the capsule or along the cortical trabeculae that contained penetrating afferent-lymphatic branches and (4) The medulla was composed of medullary cords and sinuses and interlaced by coarse networks of medullary trabeculae.

As a result of such findings, we regard the structure as a “deep cortical unit” such as in the mouse or rat relating to the leading role of the immune system which is described by Belisle & Sainte-Marie (1981), Sainte-Marie et al. (1982), Hoshi et al. (1997) and Sainte-Marie et al. (2010). We assume that in large animals like dogs or bovines, this structure was achieved as a “unit complex” in which the deep cortex extended continuously with the development of trabeculae. This phenomenon is considered to be reflected by increasing body size and aging as well. Hence, the present understanding indicates that this concept is basically applicable to the lymph node of the elephant.

In the meanwhile, some authors have proposed that the lymph nodes in the elephant would be some unusual type as in the pig. It is therefore necessary to discuss this issue, because the pig lymph node has been shown to exhibit the following specific characteristics: (1) Afferent lymphatic vessel forms a central cisterna and penetrates the trabeculae; (2) The subcapsular region is largely oc-
cupied by medulla-like tissues and (3) The medulla-like tissues without any form of medullary cords and sinuses are made up of special reticular connective tissue. However, it is evident from the present observations that the elephant lymph node shares none of these characteristics.

In conclusion, we can say that the elephant lymph node exhibits little resemblance in morphology to that of the pig, but belongs to the ordinary type, comparable to the bovine and canine nodes described previously by Aijima et al.\(^4\) and Suzawa et al.\(^5\) Our concept of the unit complex is considered to be a more universal scenario for the histological structure of the lymph nodes in larger animals.

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