

The Lymphatic System

A Neglected Area In Veterinary Research

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The importance of basic knowledge of the lymphatic system has long been recognized by scientists throughout the world as well as by Federal Meat Inspection. Thus, in Circular No. 866 (U.S. Dept. of Agriculture, 1951) it is noted that "persons engaged in meat inspection should have a thorough knowledge of the lymphatic system of animals, the flesh of which is used for food." Lymph nodes play an important part in deciding the final disposition of a carcass. The M.I.D. Training Guide No. 38 (U.S. Dept. of Agriculture, 1959) underlines that "the importance of certain lymph nodes is based on location of tissues from which their afferent vessels originate."

In order to meet the required standards of the Meat Inspection Division of the U.S. Dept. of Agriculture, the anatomy book used at the present time as a reference is the 1953 edition of "Anatomy of the Domestic Animals" by Sisson-Grossman. Other references available are: "Meat Hygiene" (Miller, 1958); Circular No. 866 (U.S. Dept. of Agriculture, 1951); M.I.D. Training Guide No. 38 (U.S. Dept. of Agriculture, 1959) and "Lymphatic System" by St. Clair in Dunne's "Diseases of Swine" (1958).

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A short comparative review of "Anatomy of the Domestic Animals" (1953) with the 1914 edition of this standard text shows that the terminology and descriptive information regarding the location of the lymph nodes and their drainage areas have been essentially unchanged.

At the time Sisson worked on his 2nd edition (1914) most of the research that had been done on the lymphatic system concerned man. Bartels, in his published work on the lymphatic system of man (Jena, 1909), was able to cite 840 references, while Baum, in his first major work on the lymphatic system of the ox (Berlin, 1912) gathered 40 references of which only a few were limited entirely to domestic animals. In a reply to colleagues requesting more detailed information, Baum states in the preface of his 1912 publication: ". . . it is very unpleasant to say that the lymphatic system of the domestic animals is up to this date, poorly described and treated very much like a 'stepchild'."

Baum's publication (1912) on the lymphatic system of the ox included 78 illustrations and 165 pages of descriptive information. Eleven of those illustrations are found in Sisson-Grossman.

In 1911, Merzdorf, a student of Baum, published his dissertation about the relative weight of lymph nodes of dogs in different age groups. He also described the

location of the lymph nodes in this species. A short summary and two illustrations of his work are also found in Sisson (1914).

On the lymphatic system of the horse, Sisson (1914) found some descriptive information in French, English and German textbooks and he agreed with Baum that the information available was inadequate. Sisson's opinion was expressed in footnotes from his text such as: "The lymphatico-venous connections here (the right lymphatic duct) have not yet been satisfactorily worked out by modern methods" (Sisson-Grossman, 1953, page 711) and "The lymph vessels of these organs (intestine, stomach, liver and spleen) appear to vary considerably in their mode of termination, and the arrangement needs further study" (Sisson, 1953, page 711). Regarding terminology, Sisson (1914) had to say this: "Much confusion exists in the terminology used for these glands (the pharyngeal lymph nodes) and the next group (the anterior cervical lymph nodes)" (Sisson, 1914, page 699).

The lymphatic system of the swine is only briefly described by Sisson. He recognized that the lymph nodes of the head and neck of swine were arranged somewhat differently as compared to the ox and horse; thus he describes: "Ventral to this (subparotid gland) are two smaller glands, one above and one below the external maxillary vein" (Sisson, 1914, page 740 and Sisson, 1953, page 760) and "other small nodes are present in the fat around the trachea" (Sisson, 1914, page 741 and Sisson, 1953, page 761). At this time, very little was known about the afferent and efferent lymph vessels of swine, and the material included in Sisson's (1914) text, was as complete as any published.

The meat inspection books, also like von Ostertag's "Handbook of Meat Inspection" (1904) assumed that the basic flow of lymph in domestic animals is somewhat similar in different species of animals. This opinion was also supported by B. Bartels (1909) who states in his book on the lymphatic system, that evidently there is a basic similarity in the distribution of lymph vessels and lymph nodes in mammals and in man; and that differences found in man, compared to mammals, are

characterized by a greater number of lymph nodes.

Sisson (1914), however, must have had some doubts about the "similarity of lymph flow" and thus, he made no effort to discuss the lymph drainage areas of the lymph nodes of swine.

Bartels opinion (1909) about "the principal similarity" of flow of lymph in mammals and man received undeserved popularity because it appeared to be a simple and convenient way to solve the problems of descriptive information of the lymphatic system.

In October 1925, Baum delivered a speech at the Veterinary Congress in Leipzig, and in summary he stated that Bartel's opinion leads to "easily made" erroneous conclusions and that in no case may drainage areas of lymph nodes in one species be assumed true for other species.

On the basis of comparative studies of the dog, ox, horse, and man, Baum showed that the afferent lymph vessels of single lymph nodes and of groups of lymph nodes in various species differ significantly, in spite of the fact that the location topographic-anatomically and also grouping of the lymph nodes may be the same. Similarly, he showed that lymph vessels of a certain region or of an organ in one species may go to different groups of lymph nodes than those of other species.

Only one of Baum's examples given may be illustrated here. Let us consider the lymph vessels of the liver. In the dog, the lymph vessels from the liver pass to the following lymph nodes: portal, gastric, splenic and cranial lumbar aortic. In the ox, they pass to the portal, caudal mediastinal, diaphragmatic and sternal. In the horse, they go to the portal, gastric, coeliac, renal, and lateral iliac, but also to the medial and cranial mediastinal, aortic, diaphragmatic, and to lymph nodes located at the thoracic inlet (sternal).

If Baum had given his report four or five years later, he may have been able to include many of the differences regarding the lymphatic system of swine, since around 1925 there were only a few facts known about the afferent and efferent lymph vessels of swine.

Before the first world war, Titze (1914)

worked under recommendations of von Ostertag and Zwick at the Royal Institute of Health (Germany) from 1911–1914 on an assignment to investigate the flow of lymph of the ox and swine. He injected diluted, live bovine tuberculosis cultures subcutaneously into living animals. Titze was able to confirm and extend Baum's findings (1912) in the ox, but while using similar technics in swine he found, 4 to 6 weeks after injection, that a generalized tuberculosis was present. This, however, was not the case in the bovine. Titze concluded: "In general, we have assumed that the flow of lymph in swine is similar to the ox, but as it appears to me, it is done without proper justification."

In the same year (1914), Gregor in Berlin published his Inaug. Dissertation about the lymph nodes and lymph vessels of the head and neck of swine. In his research, he utilized swine fetuses approaching term. As far as is known, Gregor was probably the first to point out that the "prescapular" (dorsal superficial cervical) lymph nodes receive lymph from lymph nodes of the head. His findings were, at that time, contrary to the known descriptions of the lymph flow of the ox and the horse. In those animals the prescapular lymph nodes did not receive afferents of the mandibular lymph node. Furthermore, Gregor's work was done on fetuses, which reduced the value of his work. However, von Ostertag mentioned Gregor's findings in his "Handbook of Meat Inspection" without giving any recommendations to change the procedures of inspection used at that time.

In 1927, Postma, a Veterinary Meat Inspector, in Amsterdam (Holland) read the latest edition of von Ostertag's textbook and found that Gregor's results supported his own observations that the drainage areas of the "prescapular" lymph node of swine may differ from that of the ox. Thus, he decided to repeat Gregor's experiments, and instead of using fetuses (like Gregor), he chose young piglets up to 60 cm. in size and also a few adult swine. There were 22 animals examined.

In April of 1927, at the Congress of Dutch Scientists and Physicians, Postma made his results public. In the essay, he

confirmed Gregor's findings, that the "prescapular" lymph node collects almost all of the lymph of the head. Postma described also the afferents of the medial retropharyngeal ("Supratharyngeal" — Sisson) lymph node. He stated the afferents arise from the conchae, mucous membranes of the nose, tongue, tonsils, larynx, pharynx; and in one case he found an afferent coming from the "prescapular" to the medial retropharyngeal lymph node. The efferents of the medial retropharyngeal lymph node formed the tracheal duct. In fact, Gregor and Postma showed that the route of lymph flow from the head of swine differs significantly from that of the ox, dog, and horse.

At the time that Postma published his findings in July of 1928, Baum had just finished his publication about the lymphatic system of the horse (1928). In January of 1929, Baum had re-examined Gregor's and Postma's results in detail and had introduced, according to his results, a new terminology for the lymph nodes of the head and neck in swine from the standpoint of comparative anatomy. (Baum's terminology will be discussed in another article to follow.)

In July of 1929, Postma, after he had studied Baum's publication, asked the readers of his previous article to adopt Baum's terminology in order to clarify several comparative anatomical details that he had failed to consider.

In general, Baum agreed with Gregor (1914) and Postma (1927) in principle. Baum (1929) stated, "It can be admitted that the prescapular lymph nodes of the swine (which are represented by three groups in swine only) show, according to their drainage areas, a special case as compared to the prescapular lymph nodes of other species. In swine the prescapular lymph nodes receive the efferent lymph vessels from the lymph nodes of the head; however, this was not found to be true for the prescapular nodes of other species of animals."

In the spring of 1932, Baum passed away and his "ready for print" publication since 1930, about the lymphatic system of swine, remained unpublished until 1938.

It was finally accomplished by Grau on the initiative of Ackerknecht. In the meantime, Ossifow (1932) in Orjonikidse (U.S.S.R.) had published "The Lymphatic System of Swine" using terminology related to human anatomy. Ossifow (1932) found the flow of lymph in the head and neck region in swine to be similar to previous references (Gregor, Postma, Baum).

In 1933, J. Egehoj from Denmark, who was well acquainted with Baum's, Gregor's and Postma's publications, questioned experiments investigating the flow of lymph performed on dead specimens.

In fact, Postma in 1928, had already criticized his own method of using dead piglets by saying "However, the direction of lymph flow on a living animal will still remain a hypothesis."

In 1933, Egehoj decided to re-examine the distribution of the lymph vessels of the subcutis of the live ox. As an injection dye, he chose a 1% watery solution of pyrrol-blue and injected it subcutaneously in animals, which were sacrificed 18 to 20 hours later. For his experiments, he used 53 animals and the total number of injections made was 145. Egehoj (1934) found that in many cases his results differed from Baum's descriptions — in some cases to a greater, in others to a lesser extent. According to Egehoj, in a few cases the differences described may be considered as being of "secondary" nature caused by contamination of the injection area, but in a few instances his results differ significantly from those of Baum.

Egehoj also worked on the lymphatic system of the swine (1934–1937). In 1936 Egehoj stated "The lymphatic system of swine is not yet completely described and this species is the one of our domestic animals we know the least about." Contrary to his earlier experiments on live oxen, Egehoj preferred to work on freshly killed swine using dyed gelatine solution as injection material. For his research, Egehoj examined 102 pigs of 60–65 kg. body weight. His findings were published in leading Danish and German Veterinary Journals from 1934–1937. His skillfully described findings represented a contribution to the lymphatic system of swine. Egehoj confirmed the findings of Gregor,

Postma and Baum about the "prescapular" nodes, and he also agreed with Baum's terminology (1929).

In 1938, Grau published Baum's "Lymphatic System of Swine," which includes 47 illustrations and 156 pages of descriptive information.

Some Meat Inspection text-books, like v. Ostertag's 1932 edition (translated into English, 1934) had already adopted Gregor's Postma's, and Baum's findings about the lymphatics and continued to add new information from Egehoj 1933–1937; Baum, 1938. Others, like "Text-book of Meat Hygiene," by Edelman (7th edition, revised by Mohler and Eichhorn, 1939), preferred to keep a more conservative position. Their decision was probably influenced by the 3rd edition of Sisson-Grossman (1938) "Anatomy of Domestic Animals," in which no essential changes were made on lymphatics. Apparently, the authors of "Sisson" had not enough evidence for changes of terminology and descriptive information. Furthermore, Egehoj (1934) had already indicated in experiments performed on live animals that differences may be found in lymph flow between live and dead animals. Nevertheless, the question remains: "What do we really know about the afferent and efferent lymph vessels on living animals?"

Thornton (England) in the preface of his first edition of the "Text-book of Meat Inspection" (1949) said, "It is a disturbing feature of British scientific literature that surprisingly little attention has been directed towards the study of meat inspection and control, and as a result the judgements and procedure have remained somewhat empirical . . ." Thornton (1949, 1952, 1957) described the lymphatic system of the ox and swine briefly. About the lymph nodes of the head and neck of pigs it is mentioned (1957) that they "are numerous and somewhat difficult to group satisfactorily," and according to Thornton (1957), "The prescapular nodes of the pig receive lymph from the lymph nodes of the head, i.e., the submaxillary, parotid and upper cervical and thus may become tuberculous as a result of a primary infection of the lymph nodes of the head or from infected tissues on the head." This

is in agreement with Gregor (1914), Postma (1927), Baum (1929), Ossifow (1932), Egehoj (1937), Schoenberg & Zietzschmann (1939, 1958), also Grau (1943) and Klimow and Akajewski (1950).

In disagreement with the above mentioned references are: Thomas Castor, in Edelman's "Text-book of Meat Hygiene," (1939), Circular No. 866 (Rev. January 1951), and St. Clair's "Lymphatic System of Swine," (1958). However, a review of various publications and textbooks illustrates that a number of authors are in disagreement about the basic flow of lymph in our domestic animals. In addition, a variety of terminology and different opinions in grouping lymph nodes has been found in the literature describing the lymphatic system. Thus, an attempt to compare scientific papers published becomes sometimes difficult, if not impossible, and the authors wish to emphasize this point. As mentioned earlier, all research that has been performed in the past on swine has dealt with demonstrating lymph vessels in the non-living animal. The authors, however, believe that previous findings should be re-evaluated on live (anesthetized) animals.

Work has been in progress in the Department of Veterinary Anatomy at Iowa State University during the past year, conducted by the senior author. The results of the research done so far on live (anesthetized) swine, by injecting T-1824 dye into various parts of the body (subcutaneously, intramuscular, intra-articular, etc.) will be published periodically. The authors have found that this type of research on the lymphatics of live animals is extremely expensive and time consuming, and they wish to express appreciation to the Veterinary Medical Research Institute for aiding, in part, in these investigations. It is firmly believed by the authors that a re-evaluation of the lymphatic system may not only be of value to the anatomist but should also contribute to the areas of pathology and meat inspection, and, thus, it is hoped that more general interest in this area may develop.

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