Vol. 17, No. 1, Spring, 2021, 59-64 *Original Article*
DOI: 10.22055/IVJ.2021.251162.2304
Journal Homepage: http://www.ivj.ir/

Radiographic and ultrasonographic evaluation of thymus in mongrel doges

Abdolvahed Moarabi[1*], Reza Avizeh[2], Mahmood Khaksary Mahabady[3] and Mahsa Badami[4]

[1] Associate Professor, Department of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran
[2] Professor, Department of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran
[3] Professor, Anatomical Science Research Center, Institute for Basic Sciences, Kashan University of Medical Sciences, Kashan, and Professor, Department of Basic Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran
[4] DVM, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran

Received: 03.10.2020 Accepted: 20.01.2021

Abstract

The thymus is an organ of the lymphatic and immune system that has great importance in young animals. This study aimed to evaluate the dimensions, echogenicity and location of the thymus in healthy mongrel puppies during the first 5 months of life using radiography and ultrasonography. For this study, two pregnant bitches from mongrel breeds were prepared and five healthy male puppies isolated after their parturition for monthly evaluation in the first 5 months of life. Radiographic evaluation of the thymus was done on plain radiographs in right lateral and ventrodorsal views. Ultrasonography also was performed with a 7.5 MHz linear transducer, while the animal was restrained on dorsal recumbency position and slightly tilted to the right or left side. Based on a two-way analysis of variance, only age had a significant effect on the dimensions of the thymus gland. The highest means (±SD) of length, width, surface and volume of the thymus were estimated 32.00±2.35 mm, 7.08±0.43 mm, 1.62±0.5 cm^2 and 0.72±0.38 cm^3, respectively, at 2 months-old puppies. On the other hand, the lowest means (±SD) of length, width, surface and volume of the thymus were estimated 24.26±2.29 mm, 6.08±0.28 mm, 1.16±0.44 cm^2 and 0.47±0.21 cm^3, respectively, at 5 months-old puppies. Thymus shadows were observed in only four radiographs taken from the ventrodorsal view of puppies. Based on the findings of the present study, it can be concluded that the thymus of mongrel puppies was regressed at about 4 months-old and ultrasonography as an available and method of choice can determine the exact dimensions of the thymus compared with X-ray examination.

Key words: Dog, Thymus, Radiography, Ultrasonography

Introduction

The thymus plays an essential role in the development of the lymphatic cellular components with the growth control of the lymphatic organs in immature animals (Konig & Liebich, 2007). Its importance is the greatest in the juvenile animal and accordingly, it reaches its maximum development three weeks after birth in dogs. Thymic involution in small animals occurs concurrently with the onset of sexual maturity and the loss of deciduous teeth. The thymus atrophies and is gradually

* **Corresponding Author**: Abdolvahed Moarabi, Associate Professor, Department of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran, E-mail: a.moarabi@scu.ac.ir

replaced by connective tissue and fat, but remnants persist into old age. The regression starts at the cranial and cervical parts of the organ so that the thoracic part remains longer. In the dog, the thymus is confined to the thorax where it occupies the ventral part of the cranial mediastinum, from the thoracic inlet to the pericardium. A larger part extends into the left surface of the pericardium than into the right, producing a characteristic shadow (sail sign) in dorsoventral radiographs of dogs under one year of age (Dyce, 2010, Han, 1989, Cardarelli, 1989).

The thymus may be seen as mediastinal tissue of moderate echogenicity with a granular, coarse, yet homogeneous echotexture ventral to mediastinal vessels. It was best imaged from a left parasternal window. Because the thymus is positioned obliquely within the ventral cranial mediastinum, it was best imaged in an oblique transverse plane, positioned to approximate thymic orientation. It is in contact with the cranial margin of the heart (Nyland, 2002, Konde & Spaulding, 1991, Ettinger & Feldman, 2005). In puppies and kittens, the thymus gland may obscure the cranial cardiac border (Kealy, 2010). In a young animal the thymus can occasionally be identified between the right cranial lung lobe and the cardiac silhouette (Thrall, 2013). Individual conformational variation between various dog breeds is quite common. In young animals (less than 1 year), the thymus is expected to be in the cranial mediastinum. If the animal was older than 1 year, the thymus has usually been involuted to the point of not being radiographically detectable. Occasionally, a remnant of the thymus may still be present. The thymus is not as readily seen in lateral thoracic radiographs (Thrall, 2013).

This study aimed toevaluate the dimensions, echogenicity and location of the thymus in healthy mongrel puppies during the first 5 months of life using radiography and ultrasonography.

Materials and Methods

For this study, two mongrel pregnant dogs were prepared and kept in two separate cages. Five male puppies were selected after their parturition. Radiographic and ultrasonographic evaluations were performed monthly for five months.

Initially, all dogs were examined and clinically confirmed to be healthy and received Polyvalent vaccines (Hipradog 7, Spain) at two and three months-old and rabies vaccines (Biocan, Czech Republic) at three months of age to prevent various diseases. They have also received the anti-parasitic drug (Caniverm, Bioveta, Czech Republic). The dogs were well fed during the study.

Preparing the animal before performing radiography and ultrasonography

The weight of all dogs was determined and recorded before the evaluation. To restraint the animals and if necessary, a mixture of ketamine at a dose of 5 mg per kg of body weight and acepromazine at dose of 0.03 mg per kg of body weight was used as an intramuscular injection.

Radiographic study

The animal was placed on a radiology table and chest radiographs including the right lateral and abdominal-dorsal or dorsal-abdominal views with a focal length of 90 cm to the film without the use of a grid were prepared. To prepare the right lateral view of the animal, the center of the X-ray was behind the scapula, in the space between the fifth ribs. The animals were irradiated when the spine and sternum were parallel and parallel to the cassette. The ventrodorsal radiographs were prepared in abdominal recumbency position while the sternum and spine were parallel. The X-ray was focused in the space between the fifth ribs (Lavin, 2003).

To prepare the dorsoventral radiographs, the animal was restraint in sternal recumbency position on the table.

Ultrasonographic study

Initially, the hair in the area was shaved from the thoracic inlet to the eighth intercostal space on the left side. Ultrasonography was performed with a 7.5 MHz linear transducer, while the animal was a restraint on dorsal recumbency position and slightly tilted to the right or left side. On the surface of the chest, a suitable image of the thymus was taken and recorded. Because the thymus is adjacent to the anterior edge of the heart, the anterior edge of the heart is imaged first, and then the image of the thymus gland with a distinct (uniform) structure is obtained by moving the transducer. Thymus length, width, area, volume, position and echogenicity were then determined and recorded (Penninck, 2008).

Statistical analysis

For statistical analysis, SPSS statistical software (version 16) was used. To compare each of the dimensions at different ages, two-way analysis of variance was used and the obtained values were considered statistically significant at the level of $P<0.05$.

Results

Radiographic results

Thymus shadow was not observed on lateral radiographs, but on radiographs of the ventrodorsal view in two cases in the second month, one case in the third month, and another one case in the fourth month (Figure 1).

Ultrasonographic approach and echogenicity of the thymus gland

The proper approach to ultrasonography was to obtain an image of the thymus in the area adjacent to the sternum and the space between ribs 1 to 6 on the left side. Because the thymus lies obliquely in the mediastinum, the transducer was placed obliquely in this area and the thymus was searched obliquely in the upper left sternum by sliding and fanning. Because the thymus is adjacent to the anterior edge of the heart, an image of this region must be taken first, and then a suitable image of the thymus gland can be obtained by moving the transducer (Figure 2). The structure of the thymus ultrasound was granular, rough and homogeneous, which was seen in the abdominal part of the mediastinal vessels.

Dimensions of the thymus gland

The mean (±SD) of width and length (in millimeters), surface area (in cm^2) and volume (in cm^3) of the thymus gland in 5 male mongrel dogs are presented in Table 1.

Thymus gland width

The mean (±SD) of the total width of the thymus gland in the first 5 months of life was 6.56±0.63 mm, with the highest and lowest mean widths in the second (7.08±0.43 mm) and the fifth month (6.08±0.28 mm), respectively (Table 1). Bilateral analysis of variance showed that age had a significant effect on the width of the thymus gland, as the maximum width of the thymus was in the second month after birth and began to decline about 4 months ($P<0.05$).

Table 1. Mean± SD of Thymus Gland Dimensions in the Mongrel Dogs.

Month Dimensions	First	Second	Third	Fourth	Fifth
Width	6.60±0.30 cb	7.08±0.43 a	6.88±0.49 b	6.24±0.46 dc	6.08±0.28 d
Length	28.10±1.82 c	32.00±2.35 a	30.10±2.41 b	26.08±2.10 d	24.26±2.29 e
Surface	1.47±0.20 ba	1.62±0.50 a	1.54±0.80 ba	1.23±0.20 cb	1.16±0.44 c
Volume	0.64±0.23 ba	0.72±0.38 a	0.68±0.22 ba	0.51±0.34 cba	0.47±0.21 c

Dissimilar letters indicate a significant difference

The length of the thymus gland

The mean (±SD) of the total length of the thymus gland in the first 5 months of life was 28.10±2.72 mm, with the highest and lowest mean lengths in the second (32.00±2.35 mm) and the fifth month (24.26±2.29 mm), respectively (Table1). Bilateral analysis of variance showed that age had a significant effect on the length of the thymus gland, so that the longest gland length was in the second month after birth and from about 4 months the length of the thymus gland began to decline ($P<0.05$).

Thymus gland surface

The mean (± SD) surface of the thymus gland in the first 5 months of life was 1.40±0.71 cm^2, with the highest and lowest mean surfaces in the second (1.62±0.50 cm^2) and in the fifth month (1.16±0.44 cm^2), respectively (Table 1). Bilateral analysis of variance showed that age had a significant effect on the surface of the thymus gland, as the maximum size of the thymus surface was in the second month after birth and began to decline from about 4 months ($P<0.05$).

Thymus gland volume

The mean (±SD) of the thymus gland volume in the first 5 months of life was 0.6±0.32cm, with the highest and lowest mean volumes in the second (0.72±0.38 cm^3) and the fifth month (0.47±0.21 cm^3), respectively (Table 1). Bilateral analysis of variance showed that age had a significant effect on the volume of the thymus gland, as the highest measurement of thymus volume was in the second month after birth and, the thymus volume was reduced from 4 months onwards ($P<0.05$).

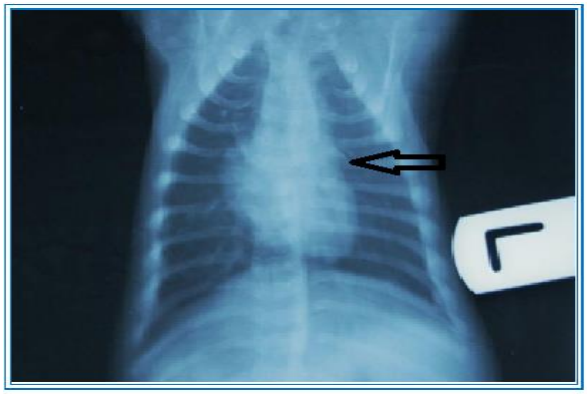

Figure 1. Abdominal radiograph of a 2-month-old male mongrel dog.

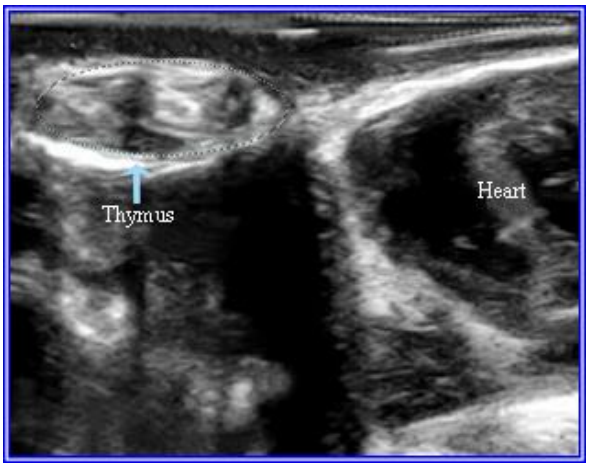

**Figure 2. Longitudinal scan of the chest of a one-month-old puppy,
Illustrated in the image of the heart and thymus.**

Discussion

The thymus is a specialized primary lymphoid organ of the immune system. Over time, the thymus begins to decrease in size and activity and the tissue of the thymus is gradually replaced by fatty tissue. This study aimed to evaluate the location of the thymus gland, echogenicity and dimensions changes in healthy mongrel dogs using radiographic and ultrasonographic methods.

According to the results of this study, the best area to obtain a proper image of the dog's thymus was on the left side of the chest and in the area adjacent to the sternum in the space between ribs 1 to 6, while the animal was placed on its right side. For this purpose, the transducer was moved

obliquely and with sliding and fanning movements, to prepare the best image of the thymus.

Nyland and Mattoon in 2002, and Penninck in 2008, believed that the thymus was the best image from a left parasternal window. Because the thymus is positioned obliquely within the ventral cranial mediastinum, it was best imaged in an oblique transverse plane, positioned to approximate thymic orientation. Also, according to Getty in 1975, the thymus was stretched between ribs 1 to 6 in full growth.

Thrall in 2013, reported that the ventral-dorsal and dorsal-ventral views are the best for imaging the thymus, and only in young animals can the thymus shadow be seen on radiographs. But in the side view, it is not possible to see the thymus. In this respect, it was consistent with the present study.

In the present study, the location of the thymus was observed in the ventral part of the anterior mediastinum and slightly ahead of the anterior edge of the heart. Dyce et al., in 2010 described the anatomical position of the thymus gland in the carnivores so that it was confined to the chest, located in the anterior mediastinal abdomen and in front of the heart. In other words, it occupies from the beginning of the chest to the pericardium.

Young et al., in 2006 similarly believed that the thymus was located in the ventral part of the anterior mediastinum near the exit of the large arteries of the heart. Its posterior part extends to the pericardium and its anterior part to the beginning of the neck.

In this study the structure of the thymus of the mongrel dogs was granular, rough, and homogeneous using ultrasonography. Thrall in 2013, believed that the thymus was seen in the neonates of dogs and cats as a mass with soft tissue opacity. He suggested that the thymus creates an opacity that was usually curved and triangular in shape and extends from the midline in a convex fashion following the medial border of the left cranial lung lobe into the left hemithorax. Nyland and Mattoon in 2002, and Penninck in 2008, reported ultrasonography of the dog thymus as a homogeneous structure, which was consistent with the present study.

In this study, age had a significant effect on the size of the thymus gland, as the maximum width, length, surface and volume of the thymus gland achieved in the second month after birth and began to decline from about 4 months.

Some researchers had similar views, pointing to how the thymus grows and increases in immature animals, as well as its deformation and degeneration after puberty (Thrall, 2013, Reichle & Wisner, 2000). Similar to the present study, Dyce et al., in 2010 suggested that the dog's thymus was the largest in its developmental period at 6-8 weeks after birth, which started to decay at about 4 months of age, and therefore coincides with the eruption of permanent teeth. Thrall also in 2013, believed that over time, the size of the thymus increased to its largest size after two months. After this period, the thymus was deformed and degenerated during a regression course, which was consistent with the present study. While Liebich and Konig in 2007, reported that the dog's thymus reaches its maximum development three weeks after birth in dogs, after this time it begins gradually to involute until the animal reaches sexual maturity. Nyland and Mattoon in 2002, stated that thymus in dogs and cats reached its maximum size at 2 months-old, and then declined and shrank, which was similar to this study.

Safieddine and Keshavjee in 2011, examined the anatomy of the human thymus gland. They reported a Human thymus weight of 13 to 15 grams at birth and 35 to 45 grams at puberty. On the other hand, with increasing age, its weight decreased to 25 grams at the age of twenty-five years old, to less than 15 grams at the age of sixty years old and 6 grams at the age of seventy years old. It should be noted that Safieddine and Keshavjee in 2011 were measured the

length of the human thymus to be 5 cm, its width to be 4 cm and its thickness to be 6 mm. In this respect, the dog's thymus appears to be smaller than the human thymus, but the ratio of the thymus to the total body size in a dog is much larger than humans.

Finally, it can be concluded that ultrasound is a more accurate and appropriate method for examining the thymus gland than radiography, further studies are necessary, due to the limited information available in this field.

Acknowledgement

This survey was financially supported by the Research Council of Veterinary Faculty, Shahid Chamran University of Ahvaz, Iran.

Conflict of interest

The authors declare that they have no conflict of interest.

Funding

This study was funded by Shahid Chamran University of Ahvaz (grant number 95791067).

References

Cardarelli, N.F. (1989*). Role of the thymus in health and senescence: thymus and immunity* (1 st Edition). Boca Raton, Florida. Pp: 23-25.

Dyce, K. M., Sack, W. O. & Wensing, C. J. G. (2010). *Textbook of Veterinary Anatomy* (4th Edition). Elsevier Health Sciences, Pp: 413-414.

Ettinger, S. J. & Feldman, E. S. (2005). *Textbook of Veterinary Medicine* (6th Edition). WB Saunders Company, Philadelphia. Pp: 1270.

Getty, R. (1975). Sisson & Grossmans. *The Anatomy of the Domestic Animals* (5th Edition). WB. Saunders Company. Pp: 1670.

Han, B. K., Babcock, D. S. & Oestreick, A. E. (1989). Normal Thymus in infancy: Sonographic Characteristics. *Radiology*. *170* (2): 471-474.

Kealy, J.K., McAllister, H. and Graham, J.P. (2010). Diagnostic Radiology and Ultrasonography of the Dog and Cat. 5ed. W.B. Saunders publisher, PP: 40-65.

Konde, L. J. & Spaulding, K. (1991). Sonographic evaluation of the cranial mediastinum in small animals. *Veterinary Radiology*. *32*(4): 178-184.

Konig, H. E. & Liebich, H. G. (2007). Veterinary Anatomy of Domestic Mammals (3th Edition). Schattauer, Germany. Pp: 484-485.

Lavin, L. M. (2003). *Radiology in Veterinary Technology* (3rd Edition). WB. Saunders Company, Philadelphia, Pp: 244-248.

Nyland, T. G. & Mattoon, J. S. (2002). *Small Animal Ultrasound* (2nd Edition). WB Saunders Company, Philadelphia. Pp: 330-332.

Penninck, D. & dAnjou, M. A. (2008*). Atlas of Small Animal Ultrasonography* (2nd Edition). Wiley-Blackwell Publishing, Pp: 121.

Reichle, J. K. Wisner, E. R. (2000). Non-Cardiac Thoracic Ultrasound in 75 feline and canine patients. *Veterinary Radiology and Ultrasound*. *41*(2): 154-162.

Safieddine, N., & Keshavjee, S. (2011). Anatomy of the thymus gland. *Thoracic surgery clinics. 21*(2), 191-195.

Thrall, D. E. (2013). *Textbook of Veterinary Diagnostic Radiology* (6th Edition). Saunders, Philadelphia. Pp: 386-388.

Young, B. James, S. Lowe, J. S. Stevens, A. & Heath, J. W. (2006). Wheater's Functional Histology: *A Text and Colour Atlas* (5th Edition). Churchill living stone Publisher, Pp: 162-165.

Received: 03.10.2020
Accepted: 20.01.2021

DOI: 10.22055/IVJ.2021.251162.2304

ارزیابی رادیوگرافی و اولتراسونوگرافی تیموس در سگ‌های نژاد مخلوط

عبدالواحد معربی[1*]، رضا آویزه[2]، محمود خاکساری‌مهابادی[3] و مهسا بادمی[4]

[1] دانشیار گروه علوم درمانگاهی، دانشکده دامپزشکی دانشگاه شهید چمران اهواز، اهواز، ایران
[2] استاد گروه علوم درمانگاهی، دانشکده دامپزشکی دانشگاه شهید چمران اهواز، اهواز، ایران
[3] استاد مرکز تحقیقات علوم تشریح، پژوهشکده علوم پایه، دانشگاه علوم پزشکی کاشان، کاشان، و استاد گروه علوم پایه، دانشکده دامپزشکی، دانشگاه شهید چمران اهواز، اهواز، ایران
[4] دانش آموخته دانشکده دامپزشکی دانشگاه شهید چمران اهواز، اهواز، ایران

تاریخ دریافت: ۱۳۹۹/۷/۱۲ تاریخ پذیرش: ۱۳۹۹/۱۱/۱

چکیده

تیموس یک عضو از سیستم لنفاوی و ایمنی بدن است که اهمیت زیادی در حیوانات جوان دارد. هدف از انجام مطالعه‌ی حاضر بررسی تغییرات اندازه، اکوژنسیته و موقعیت تیموس در توله سگ‌های سالم نژاد مخلوط با استفاده از رادیوگرافی و اولتراسونوگرافی در طی ۵ ماه اول زندگی بود. به منظور انجام این مطالعه، ۲ قلاده سگ بومی آبستن تهیه و پس از زایمان، ۵ توله سگ نر از آن‌ها جدا شد و به صورت ماهانه به مدت ۵ ماه مورد ارزیابی قرار گرفتند. ارزیابی رادیوگرافی تیموس توسط رادیوگراف‌های ساده و در نماهای جانبی راست و شکمی – پشتی بود. اولتراسونوگرافی نیز در حالی که حیوان به پشت خوابیده و کمی به سمت راست یا چپ متمایل بود، توسط ترانسدیوسر خطی ۷/۵ مگاهرتز انجام شد. بر اساس آزمون آنالیز واریانس دو طرفه فقط سن تأثیر معنی‌داری بر اندازه‌ی غده‌ی تیموس داشت. بیش‌ترین میانگین (± انحراف معیار) طول، عرض، سطح و حجم غده‌ی تیموس در ۲ ماهگی و به ترتیب برابر ۲/۳۵±۳۲/۰۰ میلی‌متر، ۰/۴۳±۷/۰۸ میلی‌متر، ۰/۵±۱/۶۲ سانتی‌متر مربع و ۰/۳۸±۰/۷۲ سانتی‌متر مکعب بود. از طرفی کم‌ترین میانگین (± انحراف معیار) طول، عرض، سطح و حجم غده‌ی تیموس در ۵ ماهگی و به ترتیب برابر ۲/۲۹±۲۴/۲۶ میلی‌متر، ۰/۲۸±۶/۰۸ میلی‌متر، ۰/۴۴±۱/۱۶ سانتی‌متر مربع و ۰/۲۱±۰/۴۷ سانتی‌متر مکعب بود. تنها در چهار مورد از رادیوگراف‌های تهیه شده از نمای شکمی-پشتی توله سگ‌های مخلوط سایه‌ی تیموس مشاهده شد. بر اساس یافته‌های این مطالعه می‌توان نتیجه گرفت که تیموس سگ‌های مخلوط از حدود ۴ ماهگی دچار تحلیل می‌شوند و اولتراسونوگرافی در مقایسه با رادیوگرافی به عنوان روشی انتخابی و در دسترس قادر به تعیین ابعاد دقیق تیموس می‌باشد.

کلمات کلیدی: سگ، تیموس، رادیوگرافی، اولتراسونوگرافی

*نویسنده مسئول : عبدالواحد معربی، دانشیار گروه علوم درمانگاهی، دانشکده دامپزشکی دانشگاه شهید چمران اهواز، اهواز، ایران
E-mail: a.moarabi@scu.ac.ir