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Review

APPLICATION OF THE COMPUTED TOMOGRAPHY AS A METHOD OF ANATOMICAL STUDY OF THE THORACIC AND PELVIC CAVITIES IN CAT AND DOG

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ABSTRACT
The method of computed tomography (CT) brought forward the question about the anatomic adequacy of the images obtained. At the beginning the carnivores were used as experimental models for the needs of human medicine. Along with the increase in canine and feline populations and in connection with the ensuing and rising diagnostic requirements the interest in CT is increasing in veterinary medicine too. Consequently the clinical cardiology is faced with different anatomical reconstructions of topographic images which impose to examine and make precise the cardiovascular structures in order to remove the diagnostic dilemmas resulting from the individual particularities, the situation of the organs in the thoracic and pelvic cavities at different body positions.

Key words: CT, anatomy, thorax, pelvis dog, cat

The method computed tomography (CT) was invented by Godfrey Hounsfield in 1970 and was based on conventional X-ray technique. Already at the time of its invention the question about the anatomical adequacy of the images obtained arose. With regard to this (1) scanned volunteers and compared CT images with transverse anatomical slices (2) have described normal CT mediastinal anatomy, and (3) has made a comparative evaluation of normal and pathological CT morphology of the heart and the great blood vessels (4) have given macroanatomical directions about the requirements of the imaging diagnosing, and (5) have traced the venous thoracic system in man through anatomical models obtained comparatively by imaging methods (routine radiography, conventional venography, CT, MRI). In order to make precise the anatomical structures in CT images, and with the aim to remove final diagnostic evaluations in human medicine (6, 7) have examined the thoracic wall and the mediastinum from anatomical point of view, and (8) has indicated the anatomical knowledge of the entrance to the thorax as an important prerequisite for the CT interpretation of the pathological conditions in this area.

CT makes possible the establishment of the anatomical localization of the heart structures (9) of the degree and character of the pathological processes in the thoracic and intrathoracic abdominal cavity (10), the evaluation of the interrelation between cardio anatomy and cardiovascular physiology (11), as well as the specifying of the coronary and heart morphology (12, 13, 14, 15, 16). A deeper CT examination of the heart and coronary vascular structures is acquired by 3-dimensional images, obtained by a 3-dimensional anatomical reconstruction. This has been put into practice with an experimental purpose by (17). Later (18) have used the opportunities of the 3-dimensional

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reconstruction for examining the epicardial anatomy in the dog,

(19) have underlined the necessity of anatomical elaboration of the mediastinal vascular structures and their variation for the interpretation of CT images in diagnoses. (20, 21, 22, 23) have made a precise analysis of the heart structures, obtained from clinical tomographic images, correlating to data from standard anatomical dissection of human hearts. This is an indisputable convenience for the diagnostic interpretation of CT images in the pathology of coronary arteries, the aortic and mitral valves (24, 25).

However, the diagnostic CT images demonstrate the heart structures not as isolated anatomical details but as multiple plains visualizing the heart between the mediastinal thoracic structures and the other thoracic organs (1, 2, 8, 10, 13, 14,19, 20, 26,27 28, 29, 30, 31).

The use of MRI as a diagnostic method imposes the specifying of the CT imaging anatomy which should be used in understanding the new diagnostic techniques and methods and their comparison (32, 33, 34, 35).

The routine use of CT in human medicine provokes the increased interest in this method in the veterinary medicine too. On the other hand the interest is caused by the cardiovascular physiology and pathology in carnivores (36, 37, 38, 39, 40). (41) highly appreciate CT as a valuable method of obtaining anatomically based pathological information.

In 1979 (17) made an experimental CT 3-dimensional anatomical reconstruction of chest cavity, heart and coronary vessels in dogs. The canine heart was also used as an experimental model for the CT definition of the heart structures in man in 1983 by (43). Other authors (44, 45) have compared the macroscopic anatomy of frozen transverse slices through the thoracic cavity with corresponding CT slices, and in an earlier publication (46) have carried out research on the thoracoscopic anatomy of dog (47); have made a correlative study of mediastinal organs and their CT images, probably in order to prove the adequacy of the computed tomography as a diagnostic method. In this regard (48) have confirmed the exclusive authenticity of CT in establishing the aortic and heart mineralization in the dog and cat.

In the field of canine vascular pathology (49) have made a 3-dimensional topographic mapping of the coronary anatomy with the aim to analyze, interpret and apply it in the imaging diagnosing.

(50) have studied the thoracic and abdominal cavities in cats with regard to the increased cat population and the needs of the ensuing and rising diagnostic requirements. The authors have compared the images obtained with anatomical slices to confirm the authencity of the method. On MRI entering veterinary medicine (51) have made analogous research. The aim is to obtain and elaborate accurate, corresponding anatomical images for CT and MRI diagnosing.

The binding of the separate CT images with a concrete thoracic vertebra is an essential reference point which could serve as an anatomical marking in the diagnostic CT study (52, 53).

Other authors (54, 55) have made a comparative description of CT slices and transverse anatomical feline specimens by putting the thoracic topography on the basis of a thoracic vertebra. The publication does not contain data about the characteristic features of the separate heart structures at the levels of examination and describes the heart as a whole CT image. We can explain this having in mind the big thickness of the slices (15 mm) chosen by the authors who impede the research and identification not only of the vascular structures but also of such considerably greater as the cardiac ones.

To successfully visualize and provide information about the cardiovascular structures in cat (52, 53, 56) have used slices 5 mm thick of the levels studied. The same thickness of the CT slices has been chosen by (45) in studying the thoracic cavity in dogs. The authors show the adequacy of CT images with these, obtained from anatomical models. The study accentuates mostly on the bone and soft tissue structures and only touches on thoracic blood vessels and the heart. The anatomical differences in the heart shape and position as well as the thorax shape in the dog and cat impose that the CT findings should not be interpreted according to analogy but species specific features should be looked for.

According to (57) the CT advantages as an anatomic and diagnostic method in the thoracic and cardiovascular pathology in carnivores are indisputable in the light of the increased interest in the thoracic anatomy, necessary for the creation of artificial human hearts or for heart xenotransplantation (58, 59).

(50) accentuate on the axial CT as a method obtaining detailed images with a good contrast of the soft tissue for anatomical and diagnostic study of thorax and abdomen in cat. The article accentuates on the necessity to know well the organ topography in order to evaluate successfully the normal and pathological findings in the thorax, abdomen, axial spine and pelvic canal.

While examining the CT reliability (44) direct their interest towards the whole scanning of canine body. The thoracic and pelvic cavities provoke their increased interest.

At the beginning the normal prostate was studied by computed tomography in man (60, 61). The gland in man is a homogenous, oval structure, characterized by soft tissue thickness, its length ranging from 2cm to 4cm, situated behind symphysis pelvis immediately under the rectum. The prostate is well visualized by computed tomography and its 3 dimensions can easily be determined. In men aged 30 its craniocaudal diameter (length) is 3 cm, the anteroposterior (height) – 2.3 cm, and the lateral (width) – 3.1 cm. By computed tomography the prostate in man is visualized as a homogenous, limited, oval, infravesical soft tissue structure which grows in size with age (14). Its height increases from 2.5 to 3 cm, and the length and width from 3 to 5 cm. Its soft tissue thickness feature ranges from 40 HU to 65 HU. The regional anatomy of the human prostate has been described by computed tomography through dividing the gland into peripheric and central gland (62). Using computed tomography (63) have studied in the male prostate the distance between: anterior and posterior glandular surface; the base and the apex; the left and the right surface; anterior surface and symphysis; posterior surface and the rectum. (64) have determined the localization of apex prostate in man using computed tomography .By comparing it with its topography, determined by magnetic resonance imaging and urethrography, they have established differences in the apex visualization depending on the methods used. (65, 66) have studied the normal male pelvis and the prostate by magnetic resonance imaging and computed tomography and have proved the bigger defining advantages of the former method in this field compared with the computed tomography. (67) have used the computed tomography and the magnetic resonance imaging to visualize the male prostate by defining 3 glandular areas – internal, external and anterior fibromuscular. (68) have used computed tomography to define the prostate length in dog and its correlation to the distance from the sacral promontory to the pelvic symphysis. A prostate longer by more than 70% than this distance is elongated and a gland longer by less than 70% is normal.

(69, 70, 71) have used radiological and endoscopic methods to study the pelvic urethra in the male cat in connection with micturition disorders as a result of disorders of the lower urinary tract. The pelvic urethra in man has often been studied by radiological methods in order to visualize the urethral bulbar narrowing – Cobb's collar and the congenital anterior diverticulum with lithiasis (72, 73, 74). The compression of the bulbar urethra by the bulbourethral grandular cysts have been studied in man by the methods of the retrograde urethrography, the computed tomography and the magnetic resonance, imaging (75, 76, 77). The anterior urethral diverticula and valves in children have been studied by radiological and endoscopic methods in connection with their bulbourethral cysts – syringocele (78).

The bulbourethral glands in man have been studied by intravenous mictional urography and have been visualized as small appendices of the male urinary tract, canal like, non-transparent findings, parallel to the urethra (10, 79). From pathogenical point of view these glands are subject to neoplasia, inflammatory processes, lithiasis and, particularly, to cyst degeneration –syringocele. Bulbourethral cysts have been observed in mouse (80) and goat (81). The bulbourethral gland in man has been studied by radiological methods in order to establish the dependence between the manifestation of syringocele and the narrowing of the bulbar urethra – Cobb's collar (72). The bulbourethral glands and their cystic degeneration in man have been studied by the methods of the retrograde urethrography, the computed tomography and the magnetic resonance imaging (75). The magnetic resonance imaging of the bulbourethral glands and their cystic degeneration has shown homogenous oval structures with cyst lesions originating from the glands and pressing against the bulbar urethra (76, 77).

Data about prostate pathology, its adjacent part of the pelvic urethra and the bulbourethral glands in a male cat, and their relation with the anatomical localization of the bladder and the urethra in healthy individuals are obtained from the research of (63, 67, 75). The authors (82, 83, 84) provide information about the anatomotopographic features of the respective organs, their dimensions and the soft tissue thickness characteristics at a CT slice 2 mm thick.

(85) have carried out CT research of the lumbosacral region in dog by obtaining computed topographic images 5 mm thick. The authors have established that the visualization of almost all elements of the region – vertebrae, tendons, appendices, nerve roots, venous plexuses, etc. is possible. (86) has used a CT study of the pelvis as a method to confirm the suspected data about the colon and rectum cancer in man in order to specify the anatomic borders of the malignant invasion.

(87) has convincingly proved CT possibilities in studying the invasion degree of ovarian and cervical carcinomas. The author has defined the anatomotographic borders of the tumor metastases.

(44) have studied the long and soft tissue structures in the canine pelvis post mortem and have obtained results about the computer tomographic features of these parts. (88) have created an anatomic computer tomographic atlas of the canine pelvis by scanning at each 13mm. In order to compare the results obtained the experimental animals have been euthanized after the end of the study and frozen slices, obtained at the same distance – 13 mm, have been prepared.

Contemporary human and veterinarian clinicists have to do different anatomic reconstructions of tomographic images. One of the big conventions is to describe the structures as unchangeable in the frame of the anatomical position. This leads to the solution of some diagnostic dilemmas on the one hand and, on the other, to the appearance of new ones, resulting from the individual characteristics and the organ situation at the different body positions (89).

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