Computed tomographic anatomy of the abdominal region of cat

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Summary

The purpose of this study was to identify the anatomic structures of the abdominal region of cat through computed tomography (CT) to be used by veterinary radiologists, clinicians and surgeons. The abdominal region of four cats were scanned twice, with and without using contrast medium in a same position, using high-resolution imaging protocol. Slice intervals were 11 mm and were adjusted so that each vertebra was sectioned at least once. CT cuts taken with and without contrast were compared for accurate identification of specific anatomic structures. Two animals were fixed by routine anatomical method and dissected for use as reference models. Finally, important structures and landmarks were identified and labeled on the CT images.

Key words: Cat, Abdomen, Computed tomography, Anatomy

Introduction

Computed tomography (CT) is a non-invasive imaging modality that has been being used in medicine for several years to diagnose and evaluate many human diseases. Recent papers have also described utilization of CT as a paraclinical survey in veterinary medicine (Moore *et al*., 1991; Burk, 1992b; Plummer *et al*., 1992; Patsikas *et al*., 2001). Characterization of the normal CT images of different animals is, however, essential for veterinary radiologists, clinicians and surgeons to interprete these images correctly. There are few papers describing normal CT anatomy of animals (Smallwood and George II, 1992; Smallwood and George II, 1993; Jones *et al*., 1995; Losonsky *et al*., 1997; Morrow *et al*., 2000; Shojaei *et al*., 2003a; Shojaei *et al*., 2003b), which are basic to effective utilization of this modality in veterinary medicine. Following the previous works (Shojaei *et al*., 2003a; Shojaei *et al*., 2003b) that demonstrated CT images of the head and thorax of the cat, herein, we identified the anatomical structures of CT images of the abdominal region of cat.

Materials and Methods

Four mature male mixed breed (domestic short hair) cats with a mean ± SD weight of 3.2 ± 0.2 kg were used in this study. After physical examination, the animals were anesthetized by intramuscular injection of 0.08 mg/kg acepromazine and 30 mg/kg ketamine and restrained in customized restraining frames. The cats were then supported in dorsal recumbency and the abdomen was scanned with a high-resolution imaging protocol using a general diagnostic CT system (Toshiba xvid, 120 kV, 200 mA, 4 sec) with a slice thickness of 11 mm. Tomograms were made almost perpendicular to the longitudinal axis of the vertebral canal and were adjusted so that each vertebra was scanned at least once. Thereafter, scanning was repeated in the same position 15 min after administration of

50 ml contrast medium (7.3 mg/kg Urographin) through a stomach tube. Then, the cats were brought to the anatomy hall in the position that they had been scanned. Two of the animals were then fixed by fixative soloution (formaline 200 ml, glycerin 50 ml, Detol 50 ml, thymol 50 g, potassium acetate 50 g, ethanol up to 1000 ml) injected in arterial system through carotid artery in order to be dissected. CT images taken with and without contrast were compared with the dissected cats. Finally, important structures and landmarks were identified and labeled on CT images.

Results

Fig. 1 shows two images of a cat in dorsal recumbency (the right one is with contrast), with lines indicating levels of each CT image. Important anatomical structures are shown in CT images with (left) and without (right) contrast (Figs. 2 to 12).

Discussion

CT scan is an excellent imaging modality. Its usage in veterinary medicine is however, limited since it is expensive and the animal should be anesthetized. Nevertheless, it has some potential advantages over routine radiography; it provides a cross-sectional image which can be used for better diagnosis of abnormalities and for evaluating the extent and severity of the lesions (Walker *et al*., 1993). In the abdominal region, this modality has a great value in identification of some diseases such as hyperadrenocorticism (Voorhout *et al*., 1988), cholangiohepatitis, chronic pan-creatitis (Nyland and Mattoon, 1995) and splenic torsion (Patsikas *et al*., 2001) in which radiography and ultrasound findings are of limited benefit. On the other hand, limited utilization of magnetic resonace imaging (MRI) in evaluation of the abdomen in veterinary medicine has been reported (Yamada *et al*., 1995; Romagnano *et al*., 1996; Muleya *et al*., 1997) and CT is considered more useful for identification of some abnormalities like the pancreatic calcification seen with chronic pancreatitis (Semelka and Ascher, 1993). It has also been used practically during recent years to diagnose special diseases (Voorhout *et al*., 1988; Hudson *et al*., 1994; Kaneps *et al*., 1995; Jones *et al*., 1999). CT can not only be used in diagnostic procedures but also can be used in many biometric research, measurements (Robina *et al*., 1991; Onar *et al*., 2002) and experimental studies (Paulus *et al*., 2000; Paulus *et al*., 2001). In all of these cases, a normal CT image is necessary for identifying anatomical structures of the animal. However, relatively few papers on normal CT anatomy are available. In 1992, those structures that are generally visualized in CT images of the nasal cavity of the German shepherd dog that could be useful for analysis of the nasal cavity lesions were identified (Burk, 1992a). In other surveys, a comprehensive atlas of CT anatomy of dog was published to be used by veterinarians (Smallwood and George II, 1992 and 1993). Nonetheless, we could find only few published papers on normal CT anatomy of cat in which nasal cavity, thorax and head had been studied (Losonsky *et al*., 1997; Shojaei *et al*., 2003a; Shojaei *et al*., 2003b). In another study, Samii *et al*., (1998) represented a normal cross-sectional anatomical atlas of the trunk of cat, with only limited abdominal cross-sectional and CT imaging com-parisons. In that study, CT images were identified according to the anatomic slices with no landmark identification. So, actually no definite approach was proposed in the article to detect specific organs. Besides, since the number of images were limited, following any changes in position, direction and size of some organs is difficult. In this study we reproduced 22 CT images of the abdominal region of cat (with and without using contrast medium), in which any minute changes in direction, position and size of the abdominal structures can be detected craniocaudally. Because of differences in body size from one animal to another, the size of cut intervals or the number of cuts can not be used as a refference to find or follow an exact organ. So we used vertebrae as refference landmarks to explain the position of abdominal structures (Table 1) which can be useful for clinicians to detect any abdominal organ in living animal through a few number of images as possible.

Fig. 1

Fig. 2

Fig. 3

Fig. 1: Ventral view of the cat CT slices (the right one is with contrast); Fig. 2: Slice number 1 of Fig. 1; 1. Sternum, 2. Abdominal fat, 3. Liver, 4. Gallbladder, 5. Spleen, 6. Stomach, 7. Caudal vena cava, 8. Esophagus, 9. Aorta and 10. 12th thoracic vertebra and Fig. 3: Slice number 2 of Fig. 1; 1. Abdominal fat, 2. Liver, 3. Gallbladder, 4. Cranial part of the duodenum, 5. Spleen, 6. Stomach, 7. Caudal vena cava, 8. Aorta and 9. 13th thoracic vertebra

Fig. 4

Fig. 5

Fig. 6

Fig. 4: Slice number 3 of Fig. 1; 1. Abdominal fat, 2. Liver, 3. Pyloric part of the stomach, 4. Stomach, 5. Spleen, 6. Small intestine, 7. Portal vein, 8. Caudal vena cava, 9. Lymph node, 10. Aorta and 11. Cranial part of the 1st lumbar vertebra; Fig. 5: Slice number 4 of Fig. 1; 1. Abdominal fat, 2. Pyloric part of the stomach, 3. Stomach, 4. Liver, 5. Ascending colon, 6. Transverse colon, 7. Spleen, 8. Small intestine, 9. Pancreas, 10. Caudal vena cava, 11. Right kidney, 12. Lymph node, 13. Aorta and 14. Caudal part of the 1st lumbar vertebra and Fig. 6: Slice number 5 of Fig. 1; 1. Small intestine, 2. Stomach, 3. Transverse colon 4. Spleen, 5. Pancreas, 6. Descending colon, 7. Descending duodenum, 8. Right kidney, 9. Caudal vena cava, 10. Lymph node, 11. Aorta, 12. Left kidney and 13. 2nd lumbar vertebra

Fig. 7

Fig. 8

Fig. 9

Fig. 7: Slice number 6 of Fig. 1; 1. Small intestine, 2. Spleen, 3. Pancreas, 4. Descending colon, 5. Caudal vena cava, 6. Right kidney, 7. Left kidney, 8. Renal papilla, 9. Renal pelvis, 10. Aorta and 11. Cranial part of the 3rd lumbar vertebra; Fig. 8: Slice number 7 of Fig. 1; 1. Small intestine, 2. Spleen, 3. Pancreas, 4. Descending colon, 5. Caudal vena cava, 6. Aorta, 7. Right kidney, 8. Renal pelvis, 9. Renal papilla, 10. Left kidney and 11. Caudal part of the 3rd lumbar vertebra and Fig. 9: Slice number 8 of Fig. 1; 1. Small intestine, 2. Spleen, 3. Descending colon, 4. Pancreas, 5. Caudal vena cava, 6. Aorta, 7. Left kidney and 8. Cranial part of the 4th lumbar vertebra

Fig. 10

Fig. 11

Fig. 12

Fig. 10: Slice number 9 of Fig. 1; 1. Small intestine, 2. Apex of the urinary bladder, 3. Spleen, 4. Descending colon, 5. Caudal vena cava, 6. Aorta, 7. Caudal pole of the left kidney and 8. Caudal part of the 4th lumbar vertebra; Fig. 11: Slice number 10 of Fig. 1; 1. Small intestine, 2. Urinary bladder, 3. Spleen, 4. Descending colon, 5. Caudal vena cava, 6. Aorta and 7. Cranial part of the 5th lumbar vertebra and Fig. 12: Slice number 11 of Fig. 1; 1. Small intestine, 2. Urinary bladder, 3. Descending colon, 4. Ureter, 5. Caudal vena cava, 6. Aorta and 7. Caudal part of the 5th lumbar vertebra

Table 1: The position (▪) of each abdominal organ according to the thoracic (T) and lumbar (L) vertebrae

	T12	T13	Cranial of L1	Caudal of L1	L2	Cranial of L3	Caudal of L3	Cranial of L4	Caudal of L4	Cranial of L5	Caudal of L5
Liver	■	■	■	■							
Gallbladder	■	■									
Spleen	■	■	■	■	■	■	■	■	■	■	
Pancreas				■	■	■	■	■			
Aorta	■	■	■	■	■	■	■	■	■	■	■
Caud. vena cava	■	■	■	■	■	■	■	■	■	■	■
Portal vein			■								
Oesophagus	■										
Stomach	■	■	■	■	■						
Pylorus			■	■							
Small intestine		■	■	■	■	■	■	■	■	■	■
Ascending colon				■							
Transverse colon				■	■						
Descending colon					■	■	■	■	■	■	■
Right kidney				■	■	■	■				
Left kidney					■	■	■	■	■		
Urinary bladder									■	■	■
Ureter											■

Another difference of this study with the one performed by Samii *et al*., (1998) is the use of contrast medium. Contrast media can be administered orally for better distinguishment of the alimentary tract and some accompanying structures such as pancreas. The present study provides a reference guide for evaluation of CT images of the abdomen of cat and can greatly assist in the interpretation of CT images dealing with pathologic or experimental changes of this region. Moreover it helps veterinary clinicians to find and follow the abdominal organs in living animal more easily.

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