

Ultrasonographic Resistive Index of the Cranial Pancreaticoduodenal Artery in Normal Conscious Dogs

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Abstract: The purpose of this study was to determine the range of resistive index(RI) of the cranial pancreaticoduodenal artery(cPDA) in the normal dog's and to assess the possibility of clinical application of RI for diagnosing a pancreatitis. Five patients with acute pancreatitis and 17 healthy adult beagle dogs were used. Duplex color Doppler ultrasonographic examination was performed by using a real-time scanner with 11-MHz linear-array transducer. The dogs were restrained in dorsal recumbency without the use of chemical agent. The mean RI of the normal pancreas(0.63 ± 0.04) was significantly($t = 5.79, p = 0.001$) different from acute pancreatitis dog(0.75 ± 0.04). Duplex color Doppler ultrasonography was an useful technique for detecting and measuring RI of the cPDA. The evaluation of RI of the cPDA may be a valuable supportive diagnostic procedure for evaluating the pancreatitis or suspected in dogs.

Key words : cranial pancreaticoduodenal artery, resistive index, pancreatitis, ultrasound, dog

Introduction

The development of ultrasonography and its measurement technique has led to the use of non-invasive evaluation of hemodynamic changes of intra-organic artery^{3,5-7,12,13,17-19} include pancreas^{1,10,11,15}. Because of the real time assessment of the blood flow, duplex color doppler permits to select the artery and measure of resistive index^{1,16}. The resistive index(RI) is a popular parameter to interpret the shape of the waveform of a blood vessel and obtained by Doppler imaging correlated with vascular resistance. The RI is defined as (S-D)/S, where S is the height of systolic peak and D is the height of the end diastolic trough¹⁴. A high RI means increased distal vascular resistance and decreased perfusion to the peripheral tissue^{9-13,17,18}.

The RI index is clinically useful in variety of small vascular bed^{2,4,6,11,15}. The RI has been used as an indicator in assessing a transplanted target organ damage^{10,11,13} or pancreatitis^{2,3,10,13,19}. Some studies indicated that RI was effective evaluating factor in patients with renal diseases^{5,6,1}, prostatic disease¹⁷ and glaucoma^{4,12}. There has been reported that RI was elevated in these patients compared with healthy control group.

RI evaluation in humans, which was determined from the proper hepatic artery, celiac artery, and superior mesenteric artery has no significant difference in the patient with severe acute pancreatitis compared in patient with mild to moderate acute pancreatitis¹⁵. In one experimental study, pancreatic and gastroduodenal arterial flow decreased immediately during the early phase of experimentally induced acute necrotizing pancreatitis in dogs¹⁹. To our knowledge, however, a hemodynamic evaluation of cranial pancreaticoduodenal artery(cPDA)

in the normal or naturally occurred pancreatitis has not been studied in dogs.

The purpose of the present study was to find the range of RI of the cPDA in the normal dogs and to assess the possibility of clinical application of RI in the dog diagnosed as acute pancreatitis.

Materials and Methods

Seventeen healthy adult beagles were used in this study. Their mean age was 20 months old(ranging 16 to 25 months) and the mean body weight was 9.0 kg (ranging 8.3 to 11.5 kg). No dog had signs of gastrointestinal disease, and the dogs were evaluated to be healthy on the basis of physical and laboratory examination. The dogs were fed commercial dry food, with water available ad libitum.

We select pancreatitis dogs to compare with normal dogs. Five patients(two Miniature poodles and three Yorkshire terriers) with acute pancreatitis were selected by the physical examination, clinical signs, blood chemistry, radiographic and ultrasonographic findings in Veterinary Teaching Hospital of College of Veterinary Medicine, Kyungpook National University. The diagnosis of pancreatitis was established on the conditions that exactly corresponds to; spontaneous acute pain and tenderness on palpation in the upper abdomen; elevation of pancreatic enzyme levels in the blood; radiographic abnormalities characterizing of acute pancreatitis; and the exclusion of other pancreatic diseases or acute abdominal diseases from different causes¹⁵.

Duplex color Doppler ultrasonographic examination was performed in all dogs by using a real-time scanner with 11-MHz linear-array transducer(LOGIQ™ 400 PRO, GE Medical Co., USA) operating at 100% power was, 50 Hz automatic wall filter settings, and medium gain setting controls. The abdominal area shaved from the 11th intercostal space to the pelvic inlet and cleaned with alcohol, and then coupling gel

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was applied. The dogs were restrained in dorsal recumbency without the use of chemical agents.

B-mode or color mode ultrasonography was used to detect the pancreas and cPDA, respectively. The transducer was placed on the area which was assumed the beginning of the duodenum. When the duodenum was imaged longitudinally, and the transducer was slowly pivoting until the pancreaticoduodenal artery flow was imaged with the maximum diameter(Fig 1). The angle between the beam and vessel was maintained under 60 degrees, and sample volume was set up 2 mm.

The RI value was calculated automatically by the ultra-

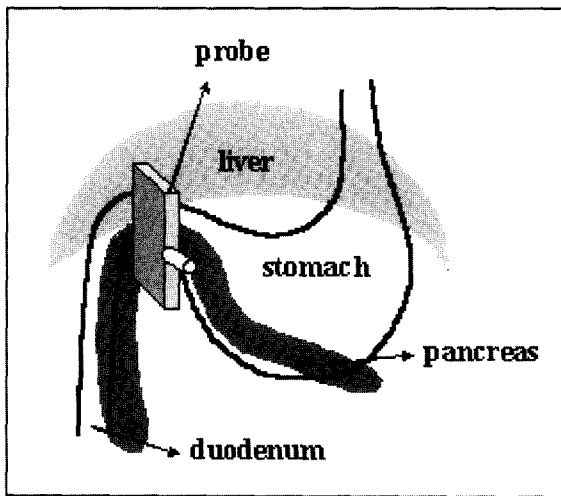


Fig 1. Ultrasonographic evaluation of the pancreas. The transducer is positioned in the last rib, and then pivoting the ultrasound beam until the blood flow of the cranial pancreaticoduodenal artery is imaged.

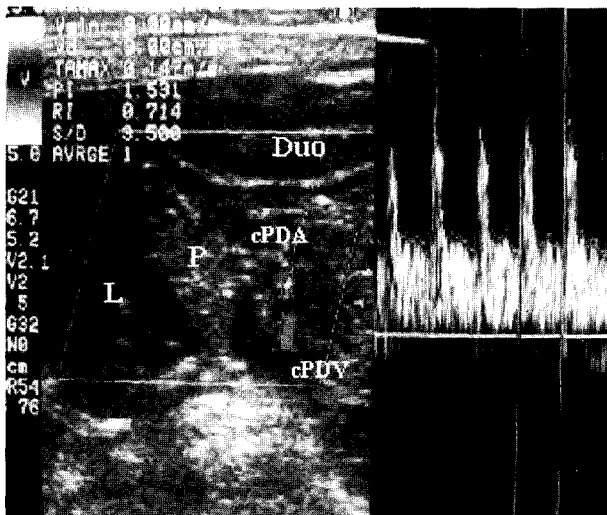


Fig 2. Color and pulsed wave Doppler spectral patterns of the cranial pancreaticoduodenal artery (cPDA) and vein (cPDV) in dog with pancreatitis. The cPDA is imaged between the duodenum (Duo) and the liver (L). The pancreas (P) is shown more hyperechoic than the liver.

sound system. Three measurements which were acknowledged uniform at least four or five pulses were performed for each imaged vessels(Fig 2).

All data are expressed as mean \pm SD. A statistical significance of the RI results between the normal and dog with acute pancreatitis was evaluated using the unpaired Student's *t*-tests. A *P* < 0.05 value was accepted statistically significant.

Results

Some dogs did not cooperated to scanning procedure, but these dogs were accommodated to repeated scanning. Though a dog with pancreatitis showed the abdominal pain in the early scanning time, it was disappeared within a few minutes. Furthermore, in patients, the RI measuring process was easier, and examination time was shorter than those in the normal and bright dog.

The pancreaticoduodenal artery and vein followed an longitudinal path through laterally the lateral right pancreatic lobe, and they could be imaged in all dogs. The examination time for selecting the constant four or five waveform pulse was required about 15 to 30 minutes each dog(Fig 2).

The mean RI of the cPDA in the normal pancreas(0.63 ± 0.04) was significantly($t = 5.79, p = 0.001$) different from that in acute pancreatitis(0.75 ± 0.04).

Discussion

Canine acute pancreatitis is commonly encountered in the veterinary practice, and it is important to early diagnosis exactly⁷. Early identification of patients that may develop serious and significant complication is desirable to ensure that appropriate treatment promptly and prospect of recovery can be predicted with some accuracy⁴. Physical examination, clinical signs, blood chemistries and radiographic or ultrasonographic evaluations have been used for detection of pancreatitis, but there is no peculiar diagnostic tool for the dogs with pancreatitis^{4,9}. Determining the degree of pancreatitis in human has been made less subjective by adaptation of clinically based classification system¹⁵. But it has not been widely used for dog's pancreatitis.

In general, pancreatitis dose not always permit sufficient changes within the pancreas for detection by ultrasonography and is diagnosed by recognizing an enlarged pancreas or ill-defined hypoechoic to complex mass in the pancreatic region^{1,3,9}. However, these findings are more or less subjective, and there was no differential method between normal and abnormal echogenicity in terms of objective observation. Fortunately, recent advances in duplex color Doppler ultrasonography make it possible to get a high quality image, to detect a small vessel within the abdominal organ and to measure its flow signals automatically^{2,4,5,10-17}. Recently, RI value has been used for the detection of organic abnormalities by evaluating arterial resistance including renal artery^{5,6}, ciliary or retinal artery in the eyes^{5,18}, and prostatic vessels¹⁷. RI value

was related to the vascular resistance¹⁴, and was appeared sensitive for detecting the early signs of target organ damage and hypertension in renal diseases^{6,7}, the increased ocular pressure in glaucoma^{5,12} and the prostatic arteriosclerosis in benign prostatic hyperplasia¹⁷. The aim of this preliminary study was to determine the standard value of the RI of the cPDA in the normal beagle dog and to evaluate the possibility of its clinical application in canine pancreatitis.

In human beings, RI value of the splanchnic artery has been measured for evaluation of severe acute pancreatitis, however, RI value was decreased and did not show correlation¹⁶. It was considered that gastroduodenal and pancreatic arterial flow decreased immediately during the early phase of acute necrotizing pancreatitis in dogs¹⁵. This decrement in the pancreatic blood flow was probably caused by large amount of bradykinin released into portal vein. It was also identified in our other experiment¹⁶, oleic acid induced pancreatitis (unpublished), RI was significantly decreased within beginning 2 days, however, considerably increased of 0.70 over 2 days after injection of oleic acid into the ductus pancreaticus accessorius. This study showed that RI of the cPDA was increased in dogs with pancreatitis, because increased vascular resistance reduces diastolic flow in greater proportion to systolic flow, and it has been also discussed in the previous study^{15,16}. The diseases include pancreatitis, mentioned above, regards as a state of vascular compression, and it will be promote to reduce of diastolic flow. Practically, a canine pancreatitis was presented with clinical signs at vet hospital some days after attacked. Judging from the these circumstance, if the pancreatitis with clinical signs will be presented, increased RI of the cPDA will be identified possibly.

The pancreas receives its arterial supply from two branches of the abdominal aorta, the celiac artery, and the cranial mesenteric artery. The right lobe of the pancreas shares arterial supply with the descending duodenum by the cranial and caudal pancreaticoduodenal arteries. In this study, the cPDA was more easier to examine than the caudal pancreaticoduodenal artery which lies under the gas-contained and locomotive stomach. The cPDA arises at the beginning of the descending duodenum and directed to the side of the right pancreatic lobe. These arteries were well identified by using a 11-MHz linear transducer. The left pancreatic lobe and its vascular pattern was relatively difficult to identify comparing with the right lobe under the gas-contained stomach. We selected the right cPDA in evaluating the hemodynamic changes of pancreatic vessels in this study. The scanning procedures including archive the optimal calculating point was interrupted by respiratory motion, intestinal or gastric peristalsis, shaking of the abdominal wall resulted from a abdominal tension caused by fear. To find out the cPDA and measure the RI, it took us fifteen to fifty minutes.

Further studies and a large number of cases are required to establish the differential tool for diagnosing a canine pancreatitis. This study suggest that RI evaluation of the cPDA may

be a useful supportive diagnostic tool and clinically applicable in canine pancreatitis.

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정상견에서 전방 췌장십이지장 동맥의 초음파학적 혈관 저항지수

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요 약 : 임상적으로 건강한 비글견 17두와 췌장염으로 진단된 5두(요크셔테리어 3두, 토이푸들 2두)의 견에서, 화학 보정 없이 전방 십이지장동맥(cranial pancreaticoduodenal artery: cPDA) 혈관저항지수(resistive index: RI)를 측정하고 이를 비교 평가하였다. RI 측정을 위해 이중 펄스 색도플러 초음파와 11-MHz 선형 위상차 배열 탐촉자를 이용하였다. 췌장염견(0.75 ± 0.04)견의 평균 RI는 정상견(0.63 ± 0.04)과 비교하여 유의성($t = 5.79, p = 0.001$)있게 증가된 소견을 보였다. 췌장염에 이환 또는 의중 환축에서 cPDA의 RI 평가 또한 보조적 진단 가치가 있음을 확인하였다.

주요어 : 전방 췌장 십이지장 동맥, 저항지수, 췌장염, 개