



HOKKAIDO UNIVERSITY

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Application of contrast-enhanced ultrasonography in diagnosis of canine pancreatic disease
(犬の膵疾患の診断における造影超音波検査の応用)

Acute pancreatitis (AP) is a common disease of the canine exocrine pancreas and accurate noninvasive diagnosis is challenging. Contrast-enhanced ultrasonography (CEUS) is a major breakthrough for ultrasound imaging and can assess organ perfusion. This study was performed in three stages to determine the feasibility of using quantitative CEUS to diagnose canine AP.

Chapter 1 aimed to (1) characterize contrast-enhancement of the pancreas using bolus injection and continuous infusion of contrast agent and (2) to assess if continuous infusion can prolong pancreatic enhancement. CEUS of the pancreas were performed in eight dogs, and time-intensity curves were generated. Four perfusional parameters were measured for statistical analysis: time to initial up-slope (TTU), peak time (Tp), time to wash-out (TTW), and peak intensity (PI). Median pancreatic contrast-enhancement was prolonged by continuous infusion from 11 (range, 10 to 23) s to 205 (170 to 264; $P < 0.01$) s. Median PI was higher during bolus injection when compared to continuous infusion (100.9 [80.2 to 124.3] MPV versus 77.6 [58.2 to 99.5] MPV; $P < 0.05$). Prolonged continuous imaging was afforded by continuous infusion. PI was slightly lower in continuous infusion, but offered adequate imaging subjectively.

Chapter 2 aimed to investigate the feasibility of CEUS in detecting pancreatic perfusional changes in cerulein-induced canine AP. Six dogs received 2 hours of IV infusion with 7.5 $\mu\text{g/kg/h}$ of cerulein diluted in saline. As control, all dogs received 2 hours of IV infusion of saline two weeks before cerulein infusion. CEUS of the pancreas were performed before (0 hour), and at 2, 4, 6 and, 12 hours after saline and cerulein infusion. Perfusion parameters TTU, Tp, TTW, PI, and area under the curve (AUC) were compared between saline and cerulein infusion. In cerulein-induced AP, PI increased at 2 and 4 hours when compared to 0 hour, and at 2, 4, and, 6 hours when compared to control. AUC increased at 4 hours when compared to 0 hour, and at 2 and 4 hours when compared to control. TTW was prolonged at 4 hours when compared to control. PI, AUC, and TTW can provide useful information in differentiating AP from normal pancreas. Cerulein-induced AP was characterized by prolonged hyperechoic enhancement on CEUS.

Chapter 3 aimed to investigate the feasibility of CEUS to detect pancreatic perfusion changes in naturally occurring pancreatitis. Twenty-three dogs diagnosed with pancreatitis were prospectively enrolled. Pancreatic CEUS were performed and perfusion parameters (TTU, Tp, TTW, PI, AUC) were compared to normal controls. Tp of the pancreatitis group was prolonged when compared to controls ($P < 0.001$). PI and AUC were increased when compared to controls ($P < 0.01$ and $P < 0.05$, respectively). CEUS can detect pancreatic

perfusion changes in naturally occurring pancreatitis and was characterized by delayed peak with prolonged hyperechoic enhancement on CEUS.

In conclusion, pancreatic CEUS protocol was established in this study, and detection of pancreatic perfusion changes both in experimentally induced and naturally occurring pancreatitis were demonstrated. CEUS is potentially useful as a new noninvasive diagnostic tool in diagnosing naturally occurring canine pancreatitis.