Abdominal ultrasound for pancreatic adenocarcinoma detection research paper sampl...

Sociology, Poverty

Pancreatic cancer (PC) is a malignant cancer that originates from cancerous cells in the pancreas. It has been estimated that 90-95% of pancreatic cancers are adenocarcinomas that originate from the exocrine part of the pancreatic tissue. Adenocarcinomas (ductal pancreatic cancer) are tumors that exhibit glandular architecture when observed under a light microscope. Pancreatic carcinoma accounts for fourth highest occurrence of cancer related deaths in the United States. The prognosis for the various stages of pancreatic cancer is poor with an estimated 25% survival rate for a person diagnosed with stage 1, while only 5-6% survival rate estimated for a stage 5 diagnosis according to American Cancer Society statistics for 20131. Pancreatic adenocarcinoma, especially has very poor survival rates, as it is usually not associated with symptoms and by the time a patient gets diagnosed, the cancer has metastasized to other organs. The macroscopic visualization of pancreatic adenocarcinoma shows it to be a firm mass, with a light yellow-white color2. The firmness of the tumor stems from the desmoplasia and fibrosis that has infiltrated the ductal epithelium. In more advanced, aggressive cases of pancreatic adenocarcinoma, intratumoral necrosis and fibrosis is observed, with a decrease of vascular density and metastasis to distant organs and perineural invasion3.

The conventional transabdominal ultrasonography (US) is usually the first mode of diagnostic imaging for detection of pancreatic adenocarcinoma. The advantage offered by US are its wide availability, non-invasiveness and low cost. A solid mass that is detected in the US of pancreas is very commonly found to be pancreatic adenocarcinoma, however it is important to remember that not all pancreatic masses are malignant tumors3.

The visualization of the pancreas is carried out by imaging on the transverse, longitudinal and angled levels. The transducer frequency can be used between 3 and 5 MHz for adults and 5 and 7. 5 MHz for children2. The gain control of the transducer should be enhanced to get the maximum visualization and focal zone of the transducer coordinated to accurate pancreatic depth. The presence of bowel gases surrounding the pancreas can be compressed and moved, when required. In some cases a better visualization of all of the pancreatic tissue is achieved by filling it with water, altering the position of the patient from erect to lying and either right or left side observation. It is optimal to perform US following an overnight fast, with a minimum fasting period of 6 hours prior to scanning. An empty stomach ensures better pancreatic visualization and limits the presence of gas. The quality and efficiency of the imaging is dependent on the expertise level of the US technician. In order to properly receive a diagnosis, the scanning of the entire pancreas should be carried out in both transverse and longitudinal planes, which includes the head, the neck, the uncinated process, the body and the tail of the pancreas2, 3. The imaging is usually initiated in a supine position, followed by the water technique which could utilize a suspension of simethicone in water to allow for increased US transmission2. The patient is also required to consume 300-400 mL of water either standing or lying on their left side. The US evaluation of pancreas include the size, texture and contour determination. A normal healthy pancreatic tissue is observed in hyperechoic (brighter) or isoechoic pattern to the normal liver. The US exam of the pancreas should also include proper visualization of the main pancreatic duct (duct of Wirsung), intrapancreatic terminal duct, splenic and

superior mesenteric arteries and the gastric wall2.

Normal Pancreas. The pancreas arise from the duodenal buds (dorsal and ventral) fusion. The vertebra is located at the first or second lumbar vertebral level. It is usually observed to be a fairly immobile, retroperitoneal, nonencapsulated posterior organ. The pancreas can be observed/found between the duodenal loop and hilum of the spleen at a length of 12. 5-15 cm. 4

The head, uncinated process, neck, body and tail constitute the various parts of the pancreas2. A bright layer of echogenic fat surrounds the superior mesenteric artery. The splenic vein is observed at an anterior position to superior mesenteric artery, in the transverse course. The splenic vein forms the dorsal perimeter of the pancreas. The superior mesenteric vein is observed at the ‘ neck’ of the pancreas. The ucinate process is observed to cover the venous junction, the mesenteric venin then forms portal vein with pancreatic tissue present anterior and posterior to the vein2. The head of the pancreas is extended to form ucinate process which is seen behind the superior mesenteric artery. The neck of the pancreas are seen anterior to mesenteric vessels and they also separate head from the body of pancreas. The bile duct and the gastroduodenal artery are the other important features observed in the US. The second part of the duodenum forms the right border for the pancreas. The lesser sac and stomach are found to the front of the pancreas. These organs are identified by the alternating hyper and hypoechoic pattern. The sagittal scan presents the head of the pancreas lying over the inferior vena cava. The superior mesenteric vein is seen behind the pancreas at the neck’s level. The superior mesenteric vein is

observed to be in front of ucinate process. The body and tail of pancreas lie behind the stomach. Splenic vein and splenic artery, cross section view are also observed in the sagittal scan of the pancreas. A single echogenic line is observed for the pancreatic duct (duct of Wirsung) with an internal diameter of about 2-2. 5 mm. 80-85% of healthy patients have their pancreatic duct visualized in the sagittal scan2. The pancreatic tissue appears to be homogenous in healthy subjects with sometimes a mottled appearance. The pancreas appear fairly isoechogenic to the liver, because of fat infiltration to the tissue as a part of aging. However, in certain diseases, fatty infiltration of pancreas is observed such as pancreatitis, viral infection, diabetes, pancreatic stone or pancreatic cancer. The generally accepted dimensions for pancreas include 3. 5 cm for the head, 2 cm for the neck and 2. 5 cm each for body and tail of pancreas. The pancreatic size decreases with age. Under pathological conditions, alteration to the texture of pancreas and crucial enlargement is sometimes observed. (3, 5)

Fig 1. a &b Normal anatomy of pancreas in the US. a. A supine position US depicts the head (H), body (B) and tail (T) with splenic artery (SA) and liver (L). b. Another transverse view indicating the head, (H), body (B), tail(T), splenomesentric confluence (C), splenic vein(SV), inferior vena cava (IVC), aorta (A), liver (L) and superior mesenteric artery (SMA)2

Pancreatic adenocarcinomas. It has been established that about 90% of all pancreatic cancers are adenocarcinomas3. This cancer has a poor survival rate usually due to detection at a time when the cancer has metastasized. The pancreatic cancer is detected in the head region of the pancreas (60%) and many patients have jaundice due to obstruction of the common bile

duct. The other kinds of pancreatic cancer include endocrine tumors that originate from the pancreatic islet cells. These can be either insulinomas, gastrinomas, VIPomas, somatostatinomas etc. The role of US in pancreatic adenocarcinomas detection is to identify the presence of lumps/masses and to potentially distinguish between pancreatitis and malignant tumor2, 3. The most commonly identified feature of the pancreatic adenocarcinoma observed in the US is a badly defined pancreatic mass that is hypoechoic to the rest of the pancreatic tissue5. This is probably due to low acoustic impedance of the ductal adenocarcinoma5. Another identifying feature of some ductal adenocarcinomas is infiltrative margins that can spread to neighboring parenchymal tissue. As a result no unambiguous margins of tumor are observed in the US6. The other characteristic feature of US is identification of enlargement of pancreatic duct with an abrupt cutoff surrounding the pancreatic tumor growth. In some cases when no tumor growth is observable this unexplained dilation of pancreatic duct which has an abrupt cutoff is an indicator for further diagnostic screening5. Dilation to the bile duct, atrophy to the surrounding glands and vascular encasement in the surrounding area are some other features associated with pancreatic adenocarcinoma. A double duct sign which is basically enlargement of bile duct associated with pancreatic duct. Necrosis of the tissue which appears liquid like is observed in some aggressive cases of pancreatic adenocarcinomas. This necrotic region is usually seen in the middle of the tumor. This necrotic region arises due to the difference between the rate of growth and formation of new blood capillaries5. Additionally US can also indicate whether the pancreatic adenocarcinoma is operable or not.

Spreading of the cancer to distant organs such as the liver, growth of tumor beyond the head of pancreas and widespread invasion of the superior mesenteric artery or the superior mesenteric vein/portal vein are some of the markers of the pancreatic carcinoma being inoperable6.

Fig 2. Solid pancreatic tumors (a-e). a. “ A transverse US that indicates a poorly defined hyoechoic mass (T). b. Another transverse US with dilated Wirsung duct (W), bile duct (C) and hypoechoic mass (T). c. Arrows demonstrate the hypoechoic mass at the pancreatic head. e. Biliary obstruction due to pancreatic head tumor and enlargement of gall bladder (G). e. dilation of common bile duct” (cbd). 2

There are some indirect markers of the presence of pancreatic cancers that include stretching of bile and pancreatic duct, hepatic tissue metastatic, ascites, delay in gastric emptying. In a clinical study performed on 62 patients who were detected with pancreatic cancer, “ 69% patients presented biliary dilation, 34% were positive for double duct sign and 37% exhibited pancreatic duct dilation” 7. Abdominal US can detect pancreatic adenocarcinoma with 70-98% sensitivity and almost 90% specificity5. Abdominal US cannot detect pancreatic adenocarcinomas which are smaller than 1 cm in size. These can be most effectively diagnosed by endoscopic ultrasound. US is effective in identifying tumors in pancreatic tissue that is unchanged or non-inflamed. Inflammation in the pancreatic tissue can make diagnosis of pancreatic cancer difficult by US. Advancements in US technology such as evaluation of tissue of tissue stiffness which has varying acoustic impedance as compared to surrounding parenchyma can also been a sign of cancer when no lesions are visualized. This property is utilized in

the real time elastography that can evaluate the hardness or the stiffness of the pancreatic mass. The Virtual touch tissue quantification that measures the wave velocity value inside a pancreatic tumor is found to greater > 3m/s as opposed to the surrounding parenchymal mass6. The use of contrast agents in abdominal US is also proven to improve the precision of cancer detection. Contrast enhanced US (CEUS) is useful in identifying the microvascular density that is observed in different stages of pancreatic adenocarcinomas. An undifferentiated carcinoma is characterized by avascular region that is a parameter for preoperative prognosis. Furthermore the vascular density that changes during chemotherapy can be effectively demonstrated by Contrast enhanced US (CEUS) 3.

Pancreatic adenocarcinoma is the most common form of pancreatic cancer. Ductal pancreatic adenocarcinomas are detected by US, which is generally the first line of diagnosis. In some cases, abdominal US demonstrates better efficiency that CT scanning method. Furthermore, technological improvements in the US when integrated with a routine detection can lead to improved efficiency and specificity of adenocarcinoma detection that usually has poor prognosis and survival rates.

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