The Value of Diffusion Weighted MRI in Imaging of Pancreatic Pathology

Thesis

Submitted for partial fulfillment of MD. Degree in Radiodiagnosis

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2014

Acknowledgement

First of all and above all great thanks to ***Allah.***

I would like to express my deepest gratitude and thanks to Prof ***Dr. Hamed el Ghawwaby*** *Professor of Radiodiagnosis, Faculty of medicine. Cairo University, for giving me the honour of being his candidate, working under hi ssupervision, guided by her experience and precious advices and true concern.*

I also extend my thanks and appreciation to Dr. Hossam el Din Hussein ,Professor of Pathology, Faculty of medicine. Cairo University,, for his guidance and great help in supervising this work.

Words could not express my great appreciation ,thanks and respect to ***Dr. Maryse youssef*** *Lecturer of Radiodiagnosis, Faculty of medicine Cairo University, for her patience ,care and concern throughout this work, providing this essay with her scientific experience and constructive supervision.*

Last, but not least, I would like to express my respect, appreciation and thanks to my husband, my family , and my professors.

Dedication:

I dedicate this work to ***My husband.***

My family.

My professors.

For their help and assistance

Thanks for all of you.

ABSTRACT

Diffusion-weighted magnetic resonance (MR) imaging is a technique that has traditionally been used in neuroimaging for the detection of acute ischemia and other intracranial disease. Recently, diffusion-weighted imaging (DWI) has emerged as a diagnostic technique in the evaluation of various abdominal lesions. (Chow et al., 2005).

The MR signal at diffusion-weighted imaging depends on two factors: the amplitude of random displacements of water molecules (related to the ADC value) and, to a lesser extent, the b value (degree of diffusion weighting). The b value is determined on the basis of the strength and duration of the paired gradients and the time interval between their respective applications. In clinical diffusion-weighted MR imaging, the b value is generally altered by changing the strength of the diffusion gradients.(Koh and Collins, 2007).

The apparent diffusion coefficent (ADC) value has been reported to be useful for quantitatively distinguishing malignancy from benign lesions. The cause of a decrease of the ADC values is considered to be that malignancies commonly have a larger cell diameter and denser cellularity than normal tissue, which restrict water diffusion. (Chow et al., 2005).

With continuing improvement in the quality of body MR imaging sequences, single-shot T2- weighted and three-dimensional unenhanced and contrast-enhanced T1-weighted gradient-echo sequences have been successfully used to characterize cystic and solid lesions of the pancreas.(Wang et al.,2011)

Diffusion-weighted MR imaging has also been used to characterize pancreatic lesions in various pathologic entities.(Wang et al.,2011)

Because of overlap of imaging features, it is difficult to differentiate between mass-forming focal pancreatitis and pancreatic adenocarcinoma with standard cross-sectional imaging techniques, including computed tomography (CT) and con¬ventional MR imaging.(Wang et al., 2011)

The use of diffusion-weighted imaging may allow earlier detection of pancreatic adenocarcinoma, since these neoplasms have increased signal intensity on diffusion-weighted images with high b values (b > 500 sec/mm2) and relatively low ADC values because of the restricted diffusion associated with fibrosis.(Wang et al., 2011).

keyword: DWI,MR,CT,ADC

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INTRODUCTION

Pancreatic cancer has an unfavourable overall 5-year survival of about 5% and one major reason is late diagnosis. At the time of diagnosis, less than 10% of patients are candidates for the only curative treatment, surgical resection ***(Jemal et al 2008).***

One crucial consideration in the treatment of patients suspected of having pancreatic tumors is how to proceed diagnostically. So far, ultrasonography (US) and contrast material–enhanced computed tomography (CT) have been widely used to diagnose pancreatic tumors. However, in previous series, differentiating benign lesions from pancreatic cancer was considerably difficult. This dilemma is clinically relevant and to overcome this dilemma, the development of sensitive and specific imaging modalities appears highly desirable. ***(Hänninen et al,2002)***

More recently the use of magnetic resonance imaging (MRI) for detection of pancreatic tumors was demonstrated. In particular, faster sequences reduced motion artifacts substantially and facilitated successful characterization of pancreatic lesions. In addition, one major advantage of MR imaging is the possibility to examine the pancreatobiliary system non invasively**.** ***(Hänninen et al., 2002)***

Diffusion-weighted imaging is based upon the principles of Brownian motion (random thermal diffusion) of small molecules in a tissue. By applying diffusion weighting to a sequence (a combination of pulses and strong gradients) one can measure the apparent diffusion coefficient (ADC) in a given tissue and thus quantify the combined effects of capillary perfusion and water diffusion. The use of DWI as a diagnostic tool in neoplastic diseases is based on the principle that in malignant lesions cells have a larger volume and are more closely aligned to each other. This hypercellularity diminishes the extracellular space leading to restriction of the free movement of water particles resulting in a depressed ADC and hyperintensity on diffusion-weighted (DW) images. In contrast, benign lesions (such as cysts, hemangiomas) are characterised by expansion of the extracellular space and not by hypercellular populations, which in turn eases the diffusion of water molecules which is displayed as high ADC and hypointensity on DW images. ***(Robertson et al 2007)***

Diffusion-weighted magnetic resonance imaging has been used for diagnosis of diseases of the central nervous system for two decades being a particularly important tool in the diagnosis of ischemic stroke—and the musculoskeletal system for one decade. ***(Bruegel et al 2008)***

During recent years, DWI of diseases of the lower abdomen, e.g. prostate, urinary bladder, uterus and rectum, has presented promising results. DWI of the upper abdomen has been a technical challenge due to respiration, bowel peristalsis, blood flow and long acquisition times**. *(Ichikawa et al 2007)***

The implementation of ultrafast imaging techniques, such as parallel imaging, has made DWI of the upper abdomen a feasible option and has been found to be useful in differentiation of malignant from benign liver lesions. Recent studies indicate that DWI is promising also in pancreatic imaging.***(Matsuki et al 2007)***

Aim of the work

In view of an increasing use of MRI application in diagnosis and management of the pancreatic malignancies, the purpose of our study is to show the value of DW MRI in the diagnosis of pancreatic cancer and to correlate the results of DW MRI with that of pathology or tumor markers aiming to use DWI MRI as a reasonable alternative modality especially when contrast administration is contraindicated.

ANATOMY OF THE PANCREAS

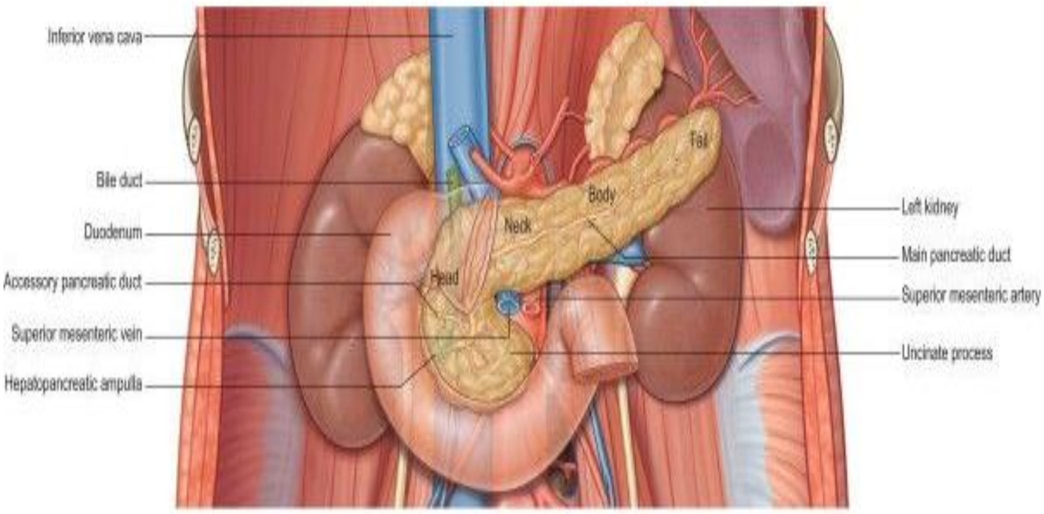
The pancreas is the largest of the digestive glands and performs a range of both endocrine and exocrine functions. The major part of the gland is exocrine, secreting a range of enzymes which are involved in the digestion of lipids, carbohydrates and proteins.***(Gray, 2008)***

The main portion of the pancreas is divided into four parts - head, neck, body and tail - and it possesses one accessory lobe (the uncinate process). The uncinate process is an anatomically and embryologically distinct portion of the pancreas. The division into the parts is purely on the basis of anatomical relations and there are only very minor functional or anatomical differences between them. ***(Gray, 2008)***

In adults the pancreas measures between 12 and 15 cm long and is shaped as a flattened 'tongue' of tissue, thicker at its medial end (head) and thinner towards the lateral end (tail). ***(Gray, 2008)***

With age, the amount of exocrine tissue tends to decline, as does the amount of fatty connective tissue within the substance of the gland, and this leads to a progressive thinning atrophy. ***(Gray, 2008)***

The pancreas lies within the curve of the first, second and third parts of the duodenum, and extends transversely and slightly upwards across the posterior abdominal wall to the hilum of the spleen, behind the stomach. It does not lie in one plane. It is effectively 'draped' over the other structures in the retroperitoneum and the vertebral column and so forms a distinct shallow curve, the neck and medial body being the most anterior parts. Because of its flattened shape, the parts of the pancreas, particularly the body, are often referred to as having surfaces and borders. ***(Gray, 2008)***



(Fig 1): Relations of the pancreas. ***(Gray, 2008)***

<u>HEAD</u>

The head of the pancreas lies to the right of the midline, anterior and to the right side of the vertebral column. It is the thickest and broadest part of the pancreas but is still flattened in the anteroposterior plane. It lies within the curve of the duodenum. Superiorly it lies adjacent to the first part of the duodenum but close to the pylorus the duodenum is on a short mesentery, and here the duodenum lies anterior to the upper part of the head. The duodenal border of the head is flattened and slightly concave, and is firmly adherent to the second part of the duodenum.. The superior and inferior pancreaticoduodenal arteries lie between the head and the duodenum in this area. The inferior border lies superior to the third part of the duodenum and is continuous with the uncinate process. ***(Gray, 2008)***

Close to the midline, the head is continuous with the neck. The boundary between head and neck is often marked anteriorly by a groove for the gastroduodenal artery and posteriorly by a similar but deeper deep groove containing the union of the superior mesenteric and splenic veins to form the portal vein. ***(Gray, 2008)***