

The Value of Diffusion Weighted MRI in Imaging of Pancreatic Pathology

Thesis

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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 coefficient (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 conventional 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 ($b > 500 \text{ sec/mm}^2$) and relatively low ADC values because of the restricted diffusion associated with fibrosis.(Wang et al., 2011).

keyword: DWI,MR,CT,ADC

Index of contents

SUBJECT	PAGE
I. Introduction and aim of work	1
II. Review of literature	
1. Anatomy of the pancreas	5
2. Pancreatic pathology	24
3. Impact of Diffusion weighted imaging in the diagnosis of pancreatic lesions.	88
4. Patients and methods	129
5. Results	132
6. Discussion	148
7. Case Presentation	153
8. Summary and Conclusion	174
9. References	176
10. Arabic summary	

LIST OF FIGURES

(Fig 1): Relations of the pancreas.....	5
(Fig 2): Regions and relations of the pancreas.	6
(Fig 3): venous drainage of the pancreas.....	7
(Fig 4): A, Posterior relations of the pancreas.	9
(Fig 5): Normal pancreatic ductal anatomy.....	12
(Fig 6): Arterial supply of the pancreas.....	15
(Fig 7): Normal signal intensity of the pancreatic parenchyma on T1-weighted image.....	19
Fig 8): MR imaging shows post contrast T1W fat-saturated images.....	20
(Fig 9): the usual low signal intensity on this T2-weighted image.....	21
(Fig 10): Pancreatic fatty infiltration.....	22
(Fig. 11): MRCP	23
(Fig 12): Development of the pancreas and intestinal adnexae.....	25
(Fig 13): Bifid pancreatic duct.....	26
(Fig 14): Pancreas divisum.....	27
(Fig 15): ERCP showing pancreas divisum.....	28
(Fig 16): MRCP of pancreas divisum.....	29
(Fig 17): Coronal (MRCP) image.....	29
(Fig 18): Diagram of annular pancreas.....	30
(Fig 19): Photograph shows annular band circling distended duodenum.....	30
(Fig 20) Annular pancreas.....	31
(Fig 21): Annular pancreas.....	32
(Fig 22): Complete annular pancreas.....	33
(Fig 23): Image from upper gastrointestinal series.....	34
(Fig 24): Pancreatic head and the absence of the corpus and tail of the pancreas.....	35

(Fig 25): CT and MRI of acute pancreatitis.....	37
(Fig 26): MR findings of acute pancreatitis.....	38
(Fig 27): Enlarged pancreas with inflammation surrounding pancreatic tail.....	39
(Fig 28): MRI showing large pseudocyst communicates with common bile duct.....	41
(Fig 29): MRI findings in advanced chronic pancreatitis.....	43
(Fig 30): CT findings in advanced chronic pancreatitis.....	44
(Fig 31): MRCP findings of chronic pancreatitis.....	44
(Fig 32): The pancreas wrapped inside large pseudocyst.	46
(Fig 33): Complicated pseudocyst.....	47
(Fig 34): Pancreatic necrosis. B, pseudocyst	49
(Fig 35): Pancreatic necrosis.....	50
(Fig 36): Focal pancreatic necrosis.....	51
(Fig 37): Black pancreas	51
(Fig 38): Peri-pancreatic inflammation extension.....	52
(Fig 39): Peri-pancreatic inflammation extension.....	53
(Fig 40): Hemorrhagic foci in pancreas.....	54
(Fig 41): Pancreatic and peri-pancreatic hemorrhage.....	55
(Fig 42): Pancreatic abscess.....	56
(Fig 43): Acute necrotizing pancreatitis and peri-pancreatic cellulitis.....	57
(Fig 44): Acute pancreatitis and a splenic artery pseudo-aneurysm.....	59
(Fig 45): The involved segments (arrows) of splenic artery (A) and splenic vein (B).....	60
(Fig 46): Stage IA pancreatic cancer.....	65
(Fig 47): Stage IB pancreatic head cancer.....	67
(Fig 48): T4 pancreatic cancer.....	68
(Fig 49): Serous (micro) cystic adenoma.....	71
(Fig 50): Oligocystic serous adenoma.....	72

(Fig 51): Mucinous cystic neoplasms.....	74
(Fig 52): Intra-ductal papillary mucinous neoplasm.....	76
(Fig 53): The typically small insulinomas.....	79
(Fig 54): Gastrinoma at the junction of the neck and body of the pancreas.....	80
(Fig 55): Non-functioning Islet cell tumors.....	82
(Fig 56): Solid pseudopapillary tumor.....	85
(Fig 57): Metastases to the pancreas.....	87
(Fig 58): Diffusion of water molecules.....	89
(Fig 59): Measuring water diffusion.....	91
(Fig. 60): DW image in a patient with a normal pancreas.....	93
(Fig.61): Pancreatic adenocarcinoma.....	95
(Fig.62): Adenocarcinoma in head of pancreas with extensive necrosis.....	96
(Fig.63): Pseudocyst related to chronic pancreatitis.....	97
(Fig 64): Poorly differentiated ductal adenocarcinoma of the pancreas.....	103
(Fig 65): Pancreatic ductal adenocarcinoma with metastases.....	105
(Fig 66): Poorly differentiated pancreatic ductal adenocarcinoma.....	107
(Fig 67): Well-differentiated endocrine neoplasm.....	109
(Fig 68): Poorly differentiated pancreatic endocrine carcinoma.....	110
(Fig 79): Pancreatoblastoma.....	112
(Fig 71): Incidentally discovered mucinous non neoplastic cyst.....	116
(Fig 72-73): Mucinous cystadenoma.....	118
(Fig 74): IPMN involving the main pancreatic duct.....	120
(Fig 75): Microcystic serous cystadenoma.....	122
(Fig 76): Colored ADC map derived from (DWI) of the pancreas.....	125

LIST OF TABLES

Table 1: Classification of pancreatic tumors.....	61
Table 2: TNM categories in pancreatic cancer.....	64
Table 3: Differential of cystic pancreatic lesions.....	70
Table 4: Demographic features of the studied group.....	132
Table 5: Location in the studied group.....	133
Table 6: Findings in the studied group.....	134
Table 7: Pathology or tumor markers in the studied group.....	135
Table 8: Pathology in the studied group.....	136
Table 9: Radiological diagnosis in the studied group.....	137
Table 10: Location of metastasis in the studied group.....	138
Table 11: Tumor necrosis in MRI.....	139
Table 12: Tumor necrosis in DWI.....	139
Table 13: Diffusion in the studied group.....	140
Table 14: Comparison between mean ADC values of benign and malignant lesions classified according pathological diagnosis in the studied patients.....	142
Table 15: Comparison between mean ADC values of normal tissue, benign and malignant lesions classified according pathological diagnosis.....	143
Table 16 :ADC of metastasis in the studied group.	144
Table 17: Conventional (radiological) vs pathology in the studied group.	144
Table 18: Pathology vs diffusion in the studied group.....	145
Table 19: ADC vs pathology in the studied group.....	146
Table 20: Diagnostic indices (sensitivity, specificity, PPV, NPV and efficacy) of MRI in the studied group.....	147

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

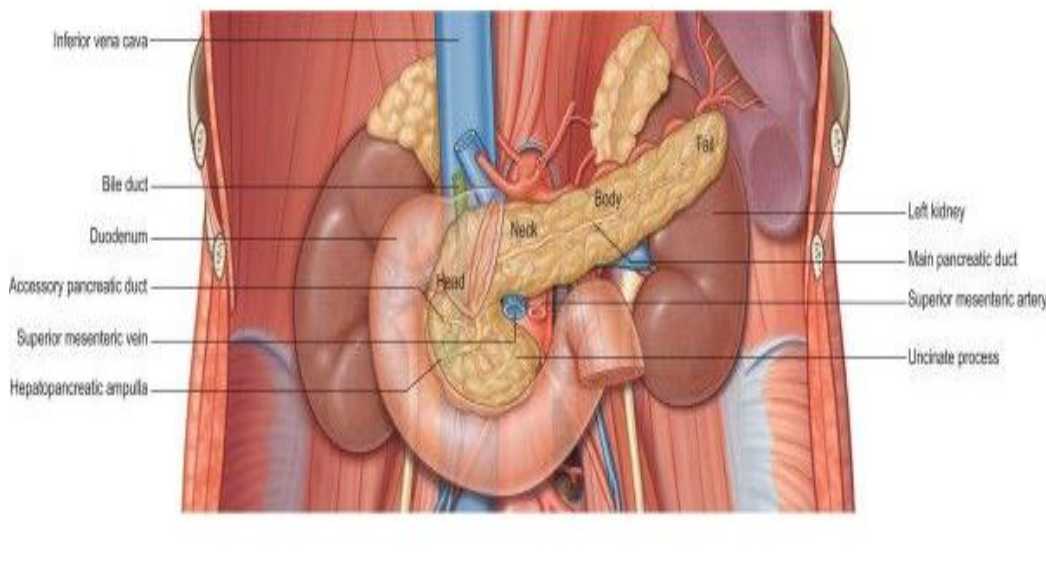
The pancreas is the largest of the digestive glands and performs a range of both endocrine and exocrine functions. The major part of the gland is exocrine, secreting a range of enzymes which are involved in the digestion of lipids, carbohydrates and proteins. *(Gray, 2008)*

The main portion of the pancreas is divided into four parts - head, neck, body and tail - and it possesses one accessory lobe (the uncinata process). The uncinata 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*)

HEAD

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*)