

## Whole Organ Perfusion of the Pancreas Using Aquilion ONE

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### Introduction

Aquilion ONE VISION EDITION, which has been introduced at the RSNA 2012, brings us a fundamentally new way to use a computed tomography (CT) scanner. With its fastest rotation time of 0.275 ms and z-coverage of 16 cm this state-of-the-art scanner provides us and our patients with robust clinical solutions every time. Not only produces Aquilion ONE VISION EDITION the highest diagnostic image quality with the lowest possible radiation exposure it also offers new clinical solutions, like dynamic imaging and whole organ perfusion. This new CT scanner allows us to scan dynamically with uniform (xyz) temporal resolution of 137.5 s and 16 cm volume coverage: from morphological to physiological diagnosis. Only few studies have been published about CT perfusion of the pancreas, partly due to the small volume of coverage with previous scanners. Aquilion ONE VISION EDITION makes it possible to scan an entire organ such as the pancreas.

During free breathing of the patient multiple sequential time points are acquired to obtain a tissue concentration curve. The time interval between acquisitions is small in the arterial phase (circa 2 seconds), is larger in the parenchymal phase (circa 3 seconds) and increases to 1 minute in the late venous phase (Fig. 1).

Because of movement of the pancreas in the z-axis during the acquisitions, the obtained high resolution perfusion images are registered with a sophisticated non-rigid algorithm, using one volume with maximal enhancement as a reference scan. Subsequently, perfusion maps can be calculated based on different models, i.e. maximum slope and patlak plot. These models have different requirements and produce different outcomes. The maximum slope is a linear approach which computes the perfusion values based on the maximum slope of the arterial time curve showing the arterial flow of the organ in ml/min/100ml. The Patlak plot relies on the backflow of contrast

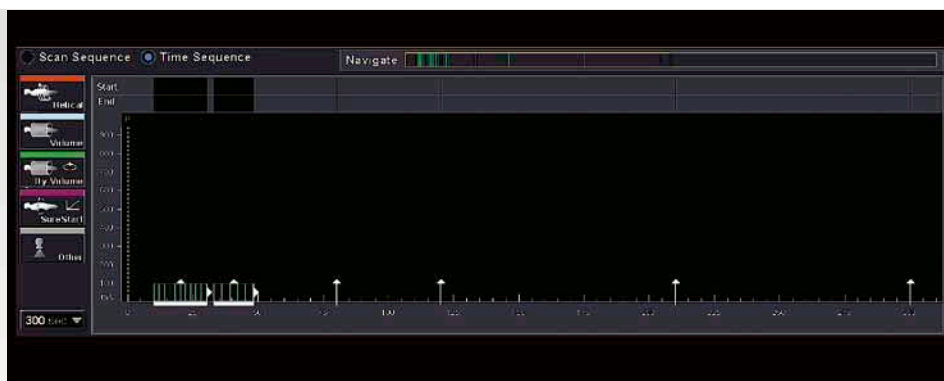


Fig. 1: Time sequence protocol

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medium from the extravascular to intravascular compartments. The exchange of contrast between blood and tissue is then calculated on the Patlak plot, which uses linear regression to analyze contrast uptake in tissue.

### Patient history and diagnosis

A 64-year-old man with vague abdominal pain was

presented at our hospital after a transabdominal ultrasound showed a hypochoic mass of about 4 cm in the uncinete process of the pancreas. C-reactive protein, liver function tests, amylase, Hb and leukocytes were all within normal range. Because of this finding the patient was analyzed within a fast track protocol for workup of pancreatico-biliary disease. After written informed

consent was obtained the patient participated in a study on CT perfusion of the pancreas and liver. The CT perfusion images were registered and the tumor in the pancreas was subsequently analyzed according to the maximum slope model and the Patlak model. With both models a 4–5 cm mass was shown in the head of the pancreas without obstruction of the common bile and pancreatic duct.

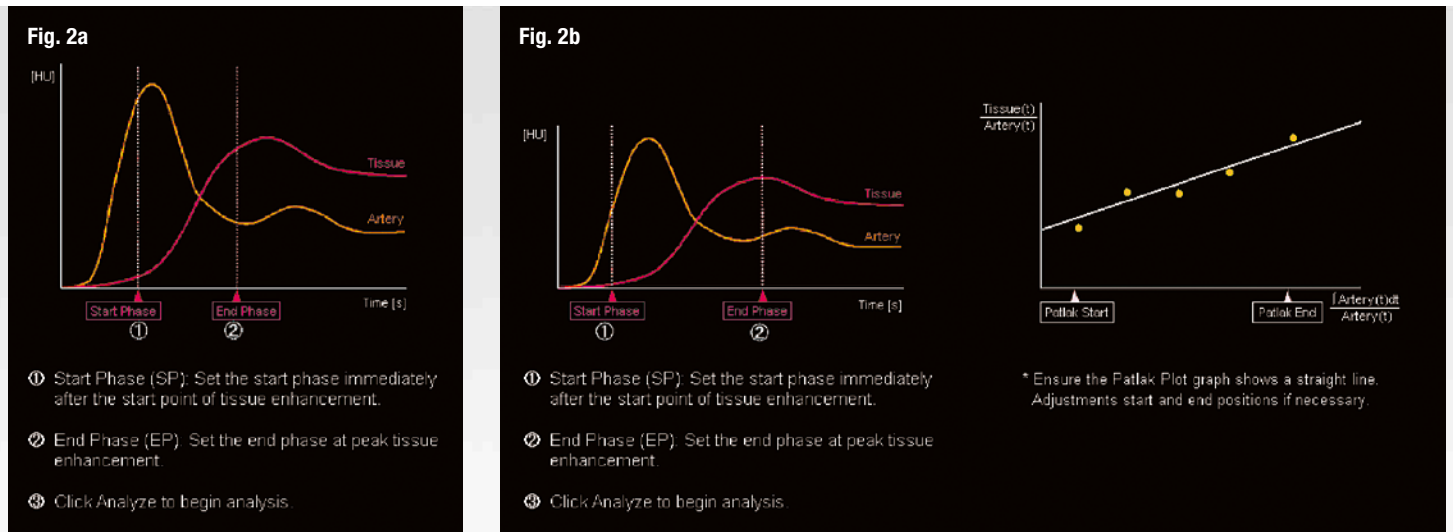


Fig. 2: Two different models: a) maximum slope and b) Patlak plot



Fig. 3: A small lesion in segment six of the liver with high signal intensity on a coronal HASTE image without contrast enhancement in the late venous phase, characteristic of a small cyst

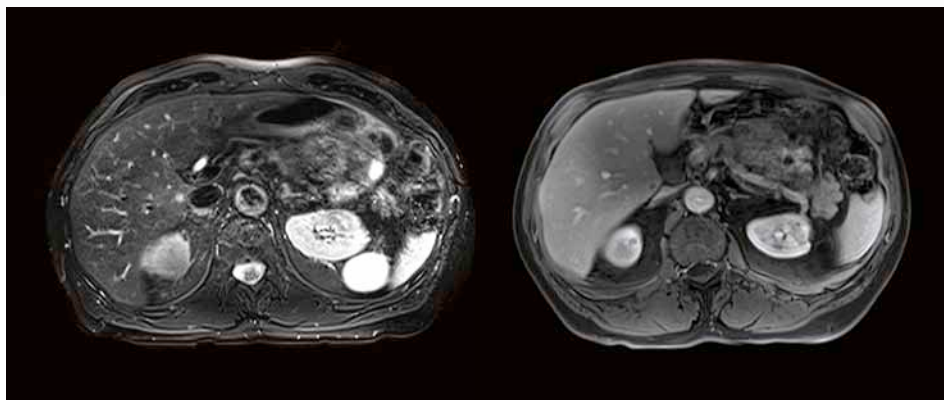


Fig. 4: Small lesion in the base of the caudate lobe with increased signal intensity on T2-weighted TSE with fat suppression image and rim enhancement in the late venous phase, characteristic of a metastasis

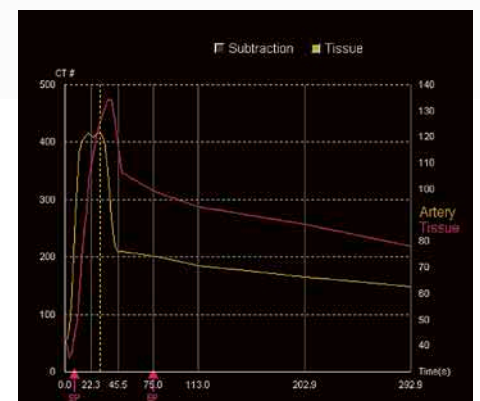


Fig. 5: Shows the enhancement curve in the aorta (artery) and in the pancreas tail (tissue)

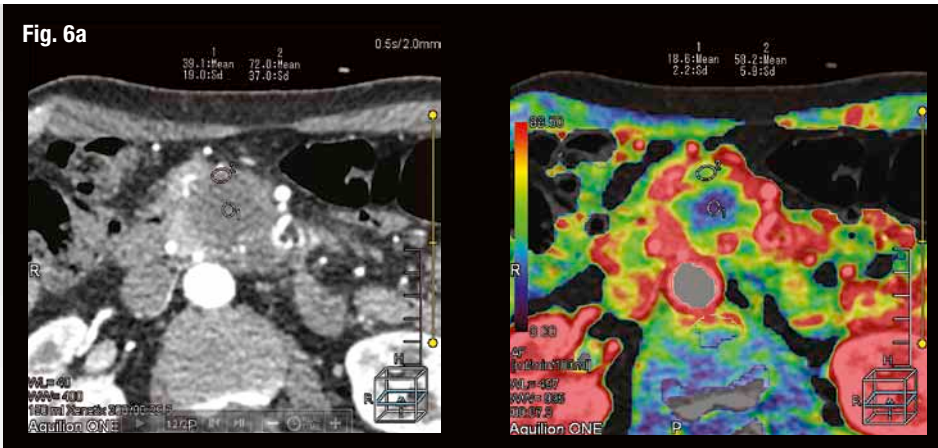


Fig. 6: Maximum slope model

- a) contrast-enhanced CT image of a large tumor in the pancreatic head
- b) Perfusion map of the tumor with ROI 1 in the central necrosis and ROI 2 in the enhancing rim

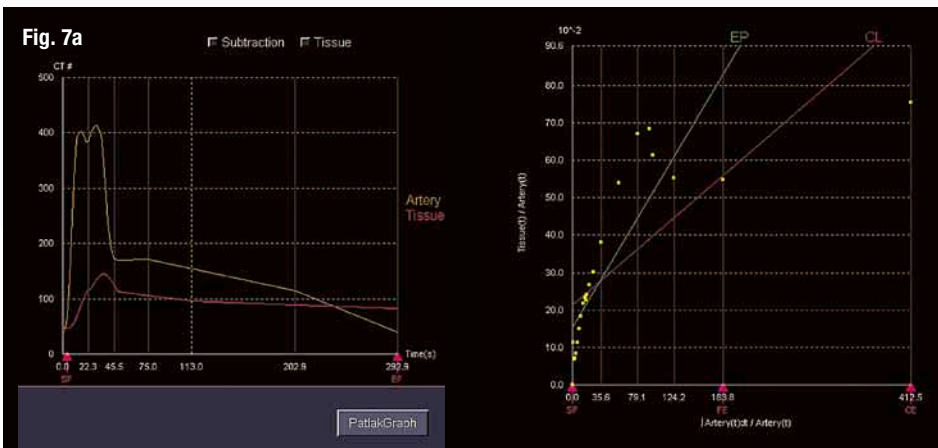
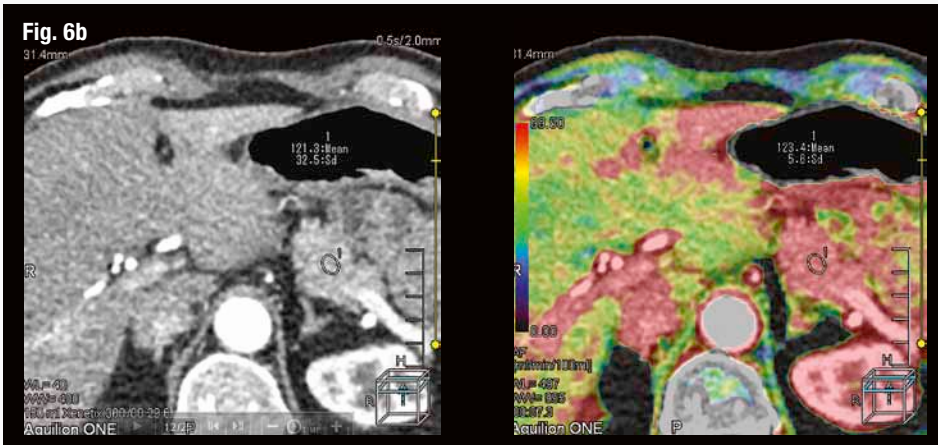
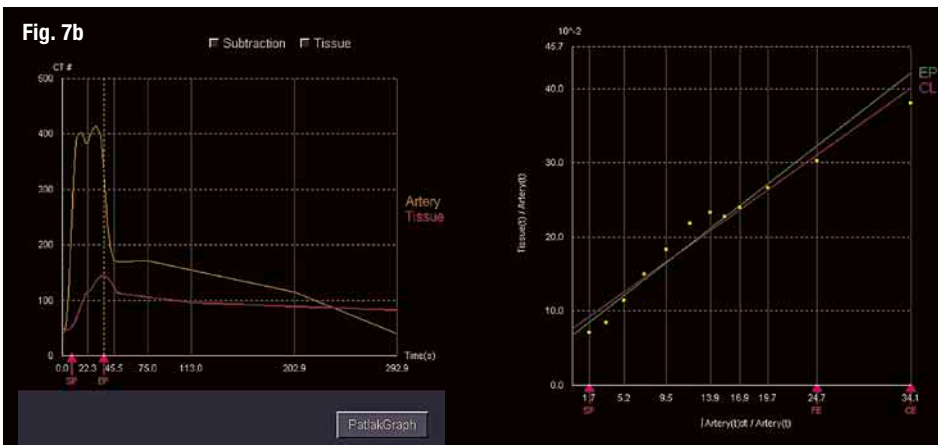


Fig. 7: Patlak graph before (a) and after (b) adjustment of start point (SP) and end point (EP)



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The mass showed a large nonperfused center. Towards the periphery of the tumor the perfusion gradually increased to normal pancreatic tissue. For perfusion analysis of the liver a dual input model was used which showed a small hyperperfused lesion of 5 mm in the caudate lobe and a small non-perfused lesion of 5 mm in segment six of the liver. On T2-weighted TSE and post-contrast MR images the lesion in the caudate lobe showed characteristics of a metastasis and the lesion in segment six of a cyst. On MRI four more metastases in the liver cupola were detected. Because the pancreatic tumor was positioned

rather caudal in the pancreas, the liver could not be completely covered within the 16 cm dynamic volume. Therefore these metastases high in segment four and eight could not be analyzed for perfusion characteristics. Because of the presence of liver metastases a curative resection of the primary pancreatic tumor was no longer feasible. To obtain a definitive diagnosis an endoscopic ultrasound (EUS) was performed which showed a multicystic mass with solid components in the pancreatic head. FNA from the solid components demonstrated malignant cells belonging to a carcinoma of the pancreas.

### Comments

Quantitative analysis of tissue microcirculation can possibly be used for biological characterization of solid pancreatic tumors and for evaluation of response to chemotherapeutic agents and/or radiotherapy. In the future perfusion parameters might be used to predict tumor aggressiveness and/or to design an individually tailored therapeutic approach.

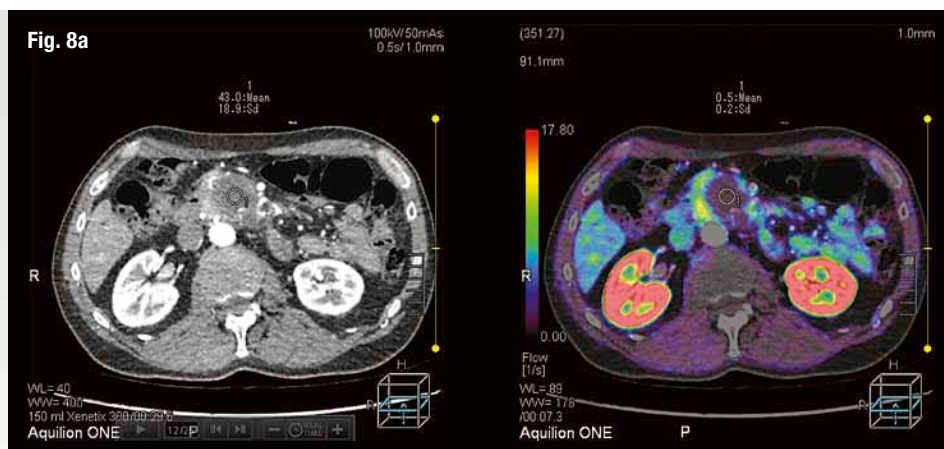
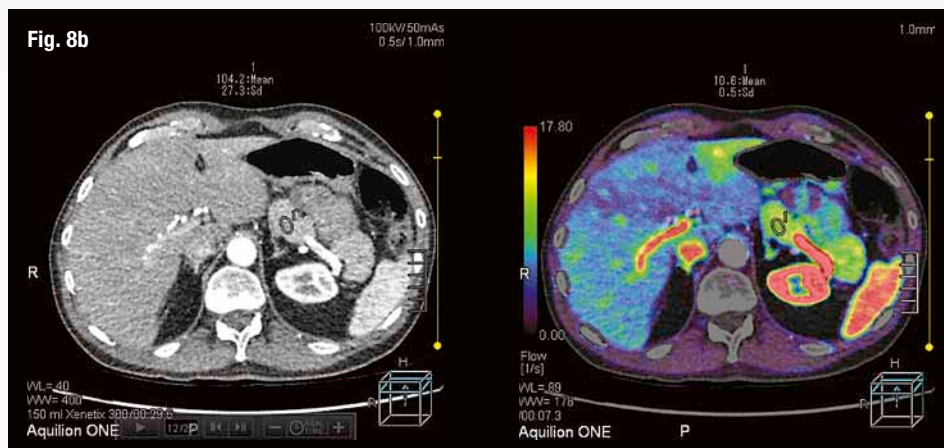


Fig. 8: Patlak model

a) perfusion map of a large tumor in the pancreatic head with central necrosis (ROI 1) with a rim of enhancing tumor tissue  
b) perfusion map of the normal pancreatic tail (ROI 1)



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