

Functional perfusion imaging of the pancreas using an arterial spin labeling technique

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Introduction

Magnetic resonance imaging has proven of value in the detection and characterization of pancreatic diseases. In addition to morphological information analysis of tissue perfusion represents a sensitive physiologic marker in the diagnosis of pancreatic malfunction. Pulsed arterial spin labeling (ASL) techniques have been introduced as a reliable tool for the assessment of tissue perfusion without the need of contrast media administration [1-3].

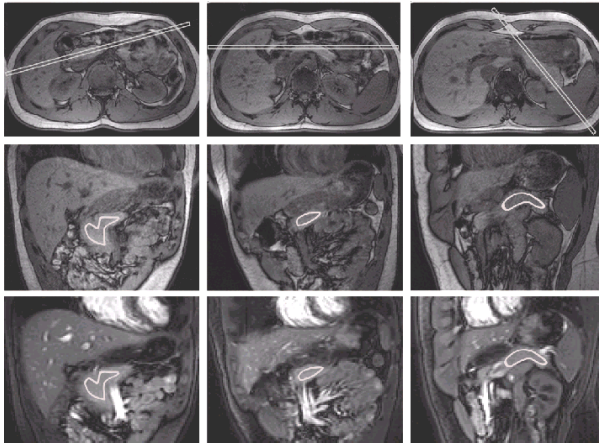
Purpose

The aim of this methodological study was to test the feasibility of perfusion imaging of the pancreas in healthy volunteers prior to and after oral stimulation by a high-caloric drink using an ASL technique.

Materials and Methods:

An ASL technique with flow-sensitive alternating inversion-recovery (FAIR) spin preparation and a true fast imaging in the steady state (TrueFISP) signal read out strategy was implemented on a 1.5 Tesla whole body unit [4,5]. Baseline perfusion and perfusion changes after ingestion of a high-caloric drink were investigated. Quantitative perfusion maps were calculated on a pixel-by-pixel basis using the extended Bloch equations.

Sequence parameters were: TR 4.02 ms, TE 2.01 ms, TI 1200 ms, bandwidth 651 Hz/pixel, SL 5 mm, excitation angle 70°. A matrix of 128 x 96 was chosen for a field of view of 320 x 320 mm. To reduce motion artifacts, volunteers were asked to breathe regularly between the acquisitions of each single magnitude image. Anatomical and perfusion imaging in three different organ parts of the pancreas were performed in ten healthy volunteers with respect to the pancreatic blood supply (Figure 1). Maximum possible distance to the aorta and the large feeding vessels was maintained in order to avoid saturation effects of the inflowing blood.



The perfusion measurements were subdivided into six series, each consisting of 40 magnitude images with slice selective and global inversion. Tissue equilibrium magnetization (M_0) was measured separately at the beginning and at the end of the measurement series. In the first series, baseline perfusion was assessed. The second series started immediately after oral administration of the chocolate drink. Another four subsequent series were acquired in order to assess the long term course of perfusion after stimulation.

Figure 1 Slice orientation for perfusion measurements

In the upper line, axial T1 weighted images of different portions of the pancreas are shown on which slice positioning for perfusion measurements was performed (white bar).

Below, the corresponding angulated T1 weighted (middle line) and FAIR TrueFISP images after slice-selective inversion prepulse (lower line) are shown. For perfusion calculations, regions of interest were manually positioned along the outline of the caput, corpus and cauda with the aid of the anatomical images, including as much pancreatic tissue as possible by avoiding large vessels at the same time.

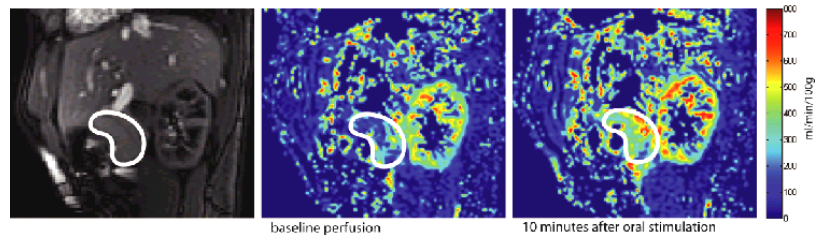
Results:

Mean examination time was 15 min for baseline perfusion imaging of the entire organ. Perfusion images of all subjects showed diagnostic image quality in the cauda and the caput. In the corpus, evaluation was impaired by motion artifacts and the relatively small organ width in three cases. However, perfusion calculation was possible in all organ parts. Mean baseline perfusion before stimulation ranged from 208 - 397 ml/min/100 g (mean: 271 ± 79 ml/min/100 g) in the caput, 166 - 505 ml/min/100 g (mean: 351 ± 112 ml/min/100 g) in the corpus and 154 - 290 ml/min/100 g (mean: 243 ± 52 ml/min/100 g) in the cauda.

In all subjects, marked increase in perfusion (mean: 77 %) was detected after oral stimulation. The individual time until maximum perfusion value was reached (time to peak) varied among the volunteers and ranged from 1 - 15 minutes.

Figure 2 Perfusion maps prior to and after stimulation

Coloured perfusion maps of the pancreatic cauda (white contour) of a 24-year-old healthy volunteer before and ten minutes after oral stimulation with the corresponding anatomical image (left).



Conclusion:

FAIR-TrueFISP provides a reliable method for functional characterization of the pancreas by means of perfusion measurements. Assessment of perfusion disorders may be useful in the diagnosis of inflammatory pancreatic pathologies, endocrine and exocrine pancreatic disorders and in monitoring of pancreatic transplants.

References:

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