MRI-Guided Transvenous Pancreatic Injections

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Introduction: Cellular therapeutics e.g. islet cell, stem cell, etc. implantation, have a potential to cure type II diabetes. This may require direct delivery of cellular materials into the pancreas or surrounding suitable anatomy. Since the pancreas or surrounding anatomy is not easily accessible by percutaneous approaches, there is a requirement to develop a transcatheter vascular approach to accurately deliver cellular agents. The objective of this work is to demonstrate the feasibility of delivering cellular agents to the pancreas in swine using a custom active guide catheter, an injection needle and a novel transvenous approach using real-time MRI guidance. Since the mesenteric venous circulation is isolated anatomically from the systemic circulation. To address this problem, the mesenteric venous bed was accessed via a percutaneous MRI guided puncture from the Inferior Vena Cava (IVC) into the portal vein, then selectively catheterizing of the splenic vein, and delivering MR contrast agent and tissue dye to the pancreas from a tranvenous approach.

Materials and Methods: Prior to any procedure, an MRA/MRV of the mesenteric venous system was performed with 30cc using Gd-DTPA (4.8 ms TR, 1.4 ms TE, 25º flip angle, 31.2 kHz BW, FOV, 256 x 256 image matrix). This allowed for dilineation of the mesenteric venous anatomy. A vascular puncture needle system [1] was used to make an access puncture from the inferior venacava (IVC) to the portal vein, in a section below the splenic vein using real-time MRI guidance. A 0.038 nitinol guidewire (Nitrex, ev3, Minneapolis, MN) was advanced in the portal vein and the puncture needle exchanged for an active guiding catheter with a built-in loopless antenna and a distal curve of 60° to enable catheter visualization and steerablity to a desired plane. Once the splenic vein was catheterized the guidewire was replaced by a nitinol needle with a heat treated soft distal section so that the distal curve of the guidecatheter was not compromised. The active guidecatheter was then steered in the orientation pointing towards the pancreas and needle advanced into the pancreas to deliver 5% Gd-DTPA contrast agent with a tissue dye (Figure 2B). The entire procedure was carried out on a 1.5T GE Signa CV/i scanner (Milwaukee, WI) using i-Drive interactive imaging interface. An SSFP sequence (TE=1.5, TR=3.4, FA=55, BW=125, 192x128 image matrix, NSA=1) with a frame rate of 2 frames/second was used to guide the procedure. The flip angle was increased to 75 degrees during contrast injection phase of the experiment and switching to a FSPGR sequence to visualize contrast injections (Figure 2C). The pancreas was examined postmortem. The experiments were carried out in healthy swine (n=3).

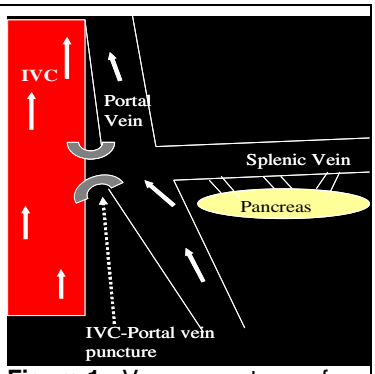

Figure 1: Venous anatomy of the pancreas and portal system.

Results: Intrapancreatic delivery MRI-contrast agent and tissue dye was carried out in 3 healthy swine. Active vascular puncture needle was used to create an access from the IVC into the portal vein at the level ~2 cm below the splenic vein. A passive guidewire was used to exchange the needle for an active guidecatheter. The active guidecatheter and the passive guidewire, which inductively coupled to the guidecatheter enabled catheterization of the splenic vein (Figure 2 a, b). When the catheter was in the splenic vein, in the region of the pancreas, the distal curved section of the guidecatheter was steered towards various sections of the pancreas, injection needle advanced and 5% dilute Gd-DTPA and tissue marker dye was injected in the pancreas. The injections are confirmed by high flip angle SSFP and SPGR imaging and postmortem histology (Figure 2 c, d).

Conclusion: We have demonstrated that a percutaneous MR Guided transvenous injection of the pancreas is feasible via the mesenteric venous circulatory system. This methodology may be used for local delivery of cellular agents such as islet cells and other biological materials to the pancreas.

References: 1: Arepally A, et al., ISMRM Annual Conference, Miami, 2005.

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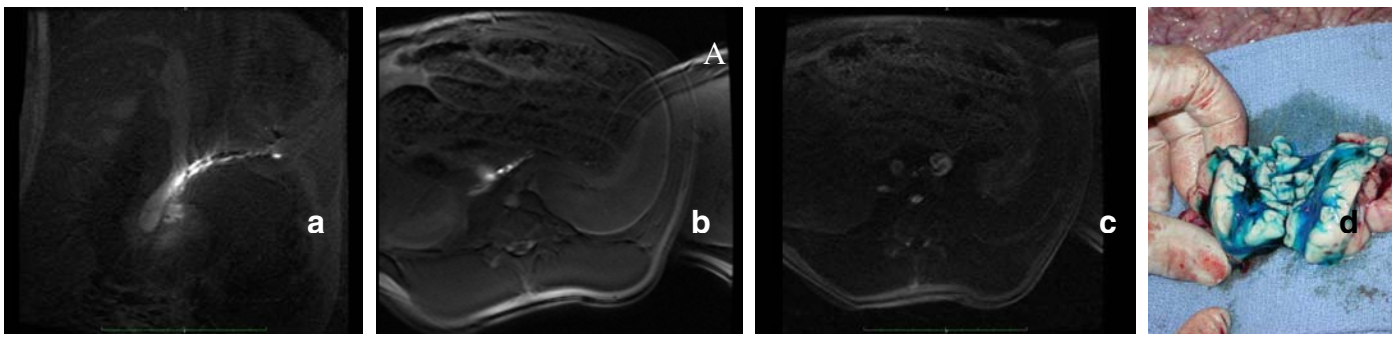

Figure 2: Catheterizing the splenic vein and delivering MR contrast agent and tissue dye under MRI guidance. a) The active catheter, with the injection needle, is advanced into the splenic vein. The portal vein and the inferior vena cava are seen in the image. b) The needle is advanced into the pancreas and a 5% MRI contrast agent with tissue dye is injected into the pancreas. c) The contrast injection is confirmed by high flip angle SPGR imaging. d) Post-mortem histology indicated successful injections in the pancreas.