MR Guided punctures of the Superior Mesenteric Vein

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Background
To determine the feasibility of performing real-time MR guided punctures of the superior mesenteric vein (SMV) from the inferior vena cava (IVC) in a swine model.

Materials and Results
Ten IVC-SMV punctures were performed in a porcine model (n=6, 90-100 lb). A novel active MR intravascular needle system that was made to form a loopless antenna was utilized for proper needle tracking and extra caval puncture. The entire procedure was performed solely under MR guidance in a conventional 1.5 T MR scanner (CV/i, GE Medical Systems Waukesha, WI). The needle was introduced through a standard clinical 12 F sheath in the common femoral vein. Using a real-time FIESTA sequence (3.4ms TR, 1.2ms TE, 45° flip angle, 30cm FOV, 6-8 frames/sec) in combination with an interactive scan plane acquisition (i-Drive, GE), the needle was advanced into the IVC and guided to the level where the SMV is closest to the IVC. Next the needle was oriented towards the SMV. A fast axial SPGR sequence (6.0ms TR, 1.5ms TE, 60° flip angle, 35cm FOV, 1 frame/sec) was used to confirm needle trajectory. Under realtime FIESTA sequence with multiplanar capability, the needle system was used to puncture the SMV from the IVC. The location of the distal tip of the needle in the SMV was then confirmed by FSE sequence with double inversion black blood (1904ms TR, 4.5ms TE, 36cm FOV). After confirmation, a direct MR portogram, using Gd-DTPA with concentration of 25%, was performed using a FSPGR (6ms TR, 1.3ms TE, 90° flip angle, no slice selection, 45 x 22.5cm FOV, 1.5 frames/sec). Successful MR guided IVC-SMV punctures was performed in all ten of the procedures. Active tracking of the needle in the IVC was possible. The needle was fully visualized as it traversed the retroperitoneum and entered the SMV. Catheterization of the portal vein was feasible and direct MR portograms were successfully performed in all punctures. All animals survived the procedures without any sequelae. MR imaging also confirmed that the needle did not traverse any retroperitoneal organs or vessels.

Conclusions
Using only MR guidance and a novel MR intravascular needle system we were able to successfully puncture the SMV from the IVC with direct visualization of the needle and all the retroperitoneal structures. We believe that a successful meso-caval puncture is the critical enabling step towards the creation of a percutaneous MR guided meso-caval shunt.