Renal Artery Embolization for Minimally Invasive Induction of Renal Failure

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Background:
New treatments for renal replacement therapy are being developed such as the BioArtificial Kidney; however, a large animal model of renal failure is needed to investigate their effectiveness. Embolization agents have been used to treat a variety of medical issues, e.g., tumors and aneurysms. We propose a minimally invasive technique to initiate complete renal failure in a swine model using a combination of nanoparticles and coils to embolize both renal arteries.

Methods:
A 5Fr catheter was placed in the right femoral artery of a 55-kg female Yorkshire pig. After the renal arteries were identified with radiopaque contrast (Conray™), particle embolization was performed with polyvinyl alcohol flakes (Contour™, 250 - 700nm), followed by coil embolization (Tornado®). After complete occlusion was confirmed, the sheath was removed and the pig was allowed to recover. Meloxicam (15mg IM) and buprenorphine (0.12mg/kg IM) were administered once for post-procedural pain. Daily blood draws and clinical assessments were performed until euthanasia, which occurred based on the veterinarian's assessment of severe metabolic derangement and/or signs of decompensation.

Results:
The procedure was well tolerated with no significant rise in inflammatory markers (white cell count and C-reactive protein). Immediate renal failure resulted from the embolization as evidenced by complete cessation of urine output. There was a progressive rise in urea and creatinine from a baseline of 8 mg/dL and 1.35 mg/dL to 95 mg/dL and 21.62 mg/dL, respectively. This coincided with worsening uremic symptoms including lethargy and decreased oral intake. On day 5, the animal was euthanized due to severe lethargy and metabolic derangements (Potassium: 8.6 mEq/L).

Conclusions:
Nanoparticle and coil embolization of the renal arteries can induce immediate renal failure in a pig. This minimally invasive technique can serve as a viable large animal model for investigating the next generation of renal replacement devices such as the BioArtificial Kidney.