An experimental study on minimally invasive percutaneous ablative approaches in the treatment of kidney tumours
Part of a PhD project by Ole Graumann

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Background
With modern diagnostic imaging such as Ultrasoundography (US), Computed Tomography (CT) and Magnetic Resonance (MR) malign complex renal cysts and small tumours in the kidneys are discovered with increasing frequency. Until now the surgical approaches have been total or partial nephrectomy through open procedures or laparoscopy, both of which may be relatively big operations. Therefore, minimally invasive surgery using ablative techniques have become a more common and feasible treatment option. Such procedures, however, are not without complications, especially damage to the renal pelvis and/or the proximal ureter.

Design and method
In an experimental study on 10 pigs we will, guided by Fusion Imaging, perform ablation with RFA and MWA. From a CT scan we will define 3 lesions in each kidney. The lesions are 3 cm in diameter and they will be placed:
1) Exophytic only involving a peripheral part of the kidney parenchyma
2) In the middle of the kidney involving only the kidney parenchyma
3) Centrally in the kidney parenchyma in direct contact with pelvis and proximal ureter

In the right kidney ablation will be performed with RFA and in the left kidney ablation will be performed with MWA. A special designed thermometer will be placed in the renal pelvis on both sides to measure temperature during ablation. In 5 pigs the renal pelvis will be irrigated with cooled saline through a ureteric catheter.

What is Ablation?
RFA
Radiofrequency waves from a needle in the tumour turn into heat, resulting in thermal damage. With frequencies between 900 MHz and 24 GHz the needle oscillating electric charge from radiation interacts with water molecules and causes molecule movement. These movements will generate friction and heat in the surrounding tissue producing coagulation necrosis.

MWA
Microwave radiation from a needle in the tumour turns into heat resulting in thermal damage. With frequencies between 900 MHz and 24 GHz the needle oscillating electric charge from radiation interacts with water molecules and causes molecule movement. These movements will generate friction and heat in the surrounding tissue producing coagulation necrosis.

To ensure coagulation necrosis of the tumour temperatures should be maintained >100 C for 8 minutes.

What is Fusion Imaging?
Fusion Imaging is a technique where data from different diagnostic imaging modalities are combined. In this study Fusion Imaging is where ultrasound (US) is combined with Computed Tomography (CT) or Magnetic Resonance (MR) using a magnet, a magnetic sensor and some advanced software. The CT/MR scan is imported to the US machine. Through different techniques volume matching are made. New technique for faster and more precise volume matching is being developed. In the future we will see great improvement in this area. When the volume matching is completed the combined US and CT/MR scan pictures can be seen either separated or overlapping.

Perspectives
Patients with incidentally discovered malignant renal cysts or small solid tumours in the kidney should be offered minimally invasive surgery. However, before minimally invasive percutaneous ablative approaches can be used in daily practice further investigation is necessary. Virtual Navigator can be quite helpful as a quick guiding modality.