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 Ultrasonography (US), Computed Tomography (CT) and Magnetic Resonance (MRI) 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.

The aim of this study

We intend to study in a pig model image-guided percutaneous ablation. We will compare Radio Frequency Ablation (RFA) and Microwave Ablation (MWA) with regard to precision of ablation. Furthermore, we will attempt to improve image guiding and study means of minimizing complications to surrounding renal parenchyma and the renal pelvis and the 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.

After the ablation the kidneys and surrounding fat tissue will be removed and examined by a pathologist.

Endpoints

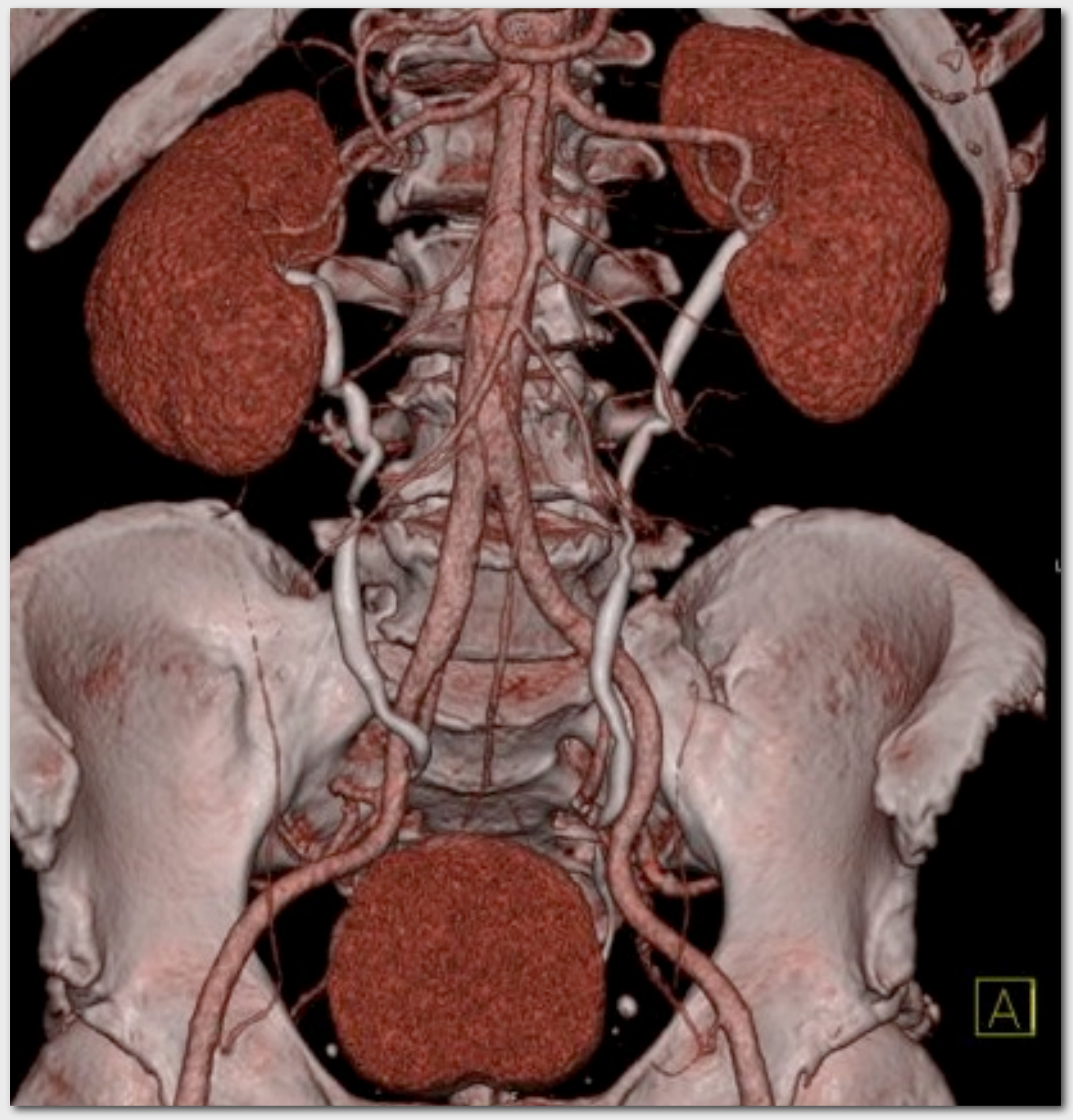
Primary endpoints are precision of ablation

1) The defined lesions in the kidneys from the CT scan will be compared with the pathologist measurements of the area with coagulation necrosis

Secondary endpoints are

1) Differences in temperatures between studies using cooled irrigation and no irrigation during treatment and differences between RFA and MWA

2) Complications from RFA and MWA as demonstrated by the pathologist's findings



What is Ablation?

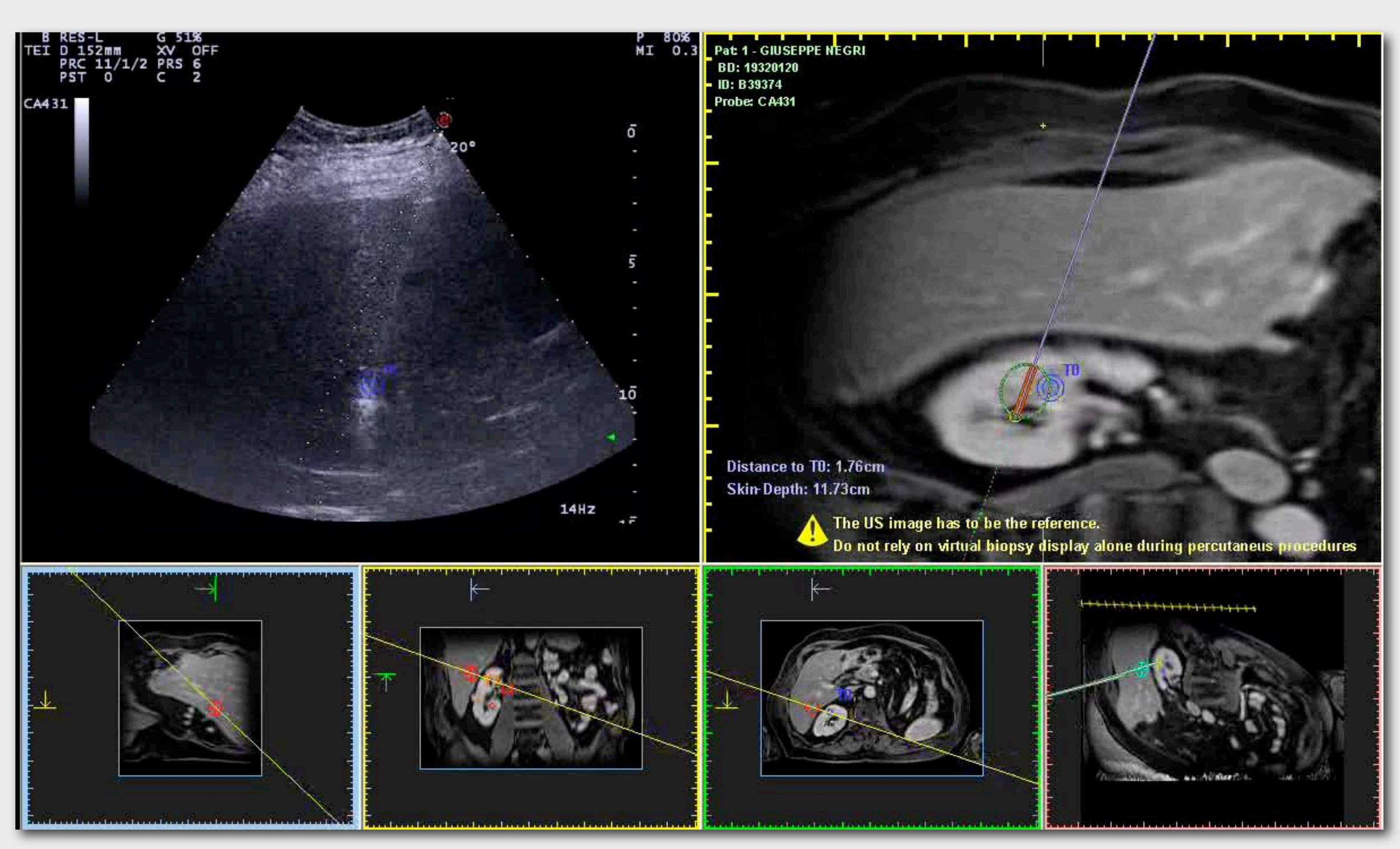
RFA

Radiofrequency waves from a needle in the tumour turns into heat, resulting in thermal damage. Continues infusion of hypertonic saline into tissue improves electrical conduction and energy is diffused from the electrode in a centrifugal direction. This is to prevent an increase in impedance and will create larger lesions in a shorter treatment time. The latest generators provide high-energy ablation up to 200 W.

MWA

Microwave radiation from a needle in the tumour turns into heat resulting in thermal damage. With frequencies between 900 MHZ and 2.4 GHz from 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.

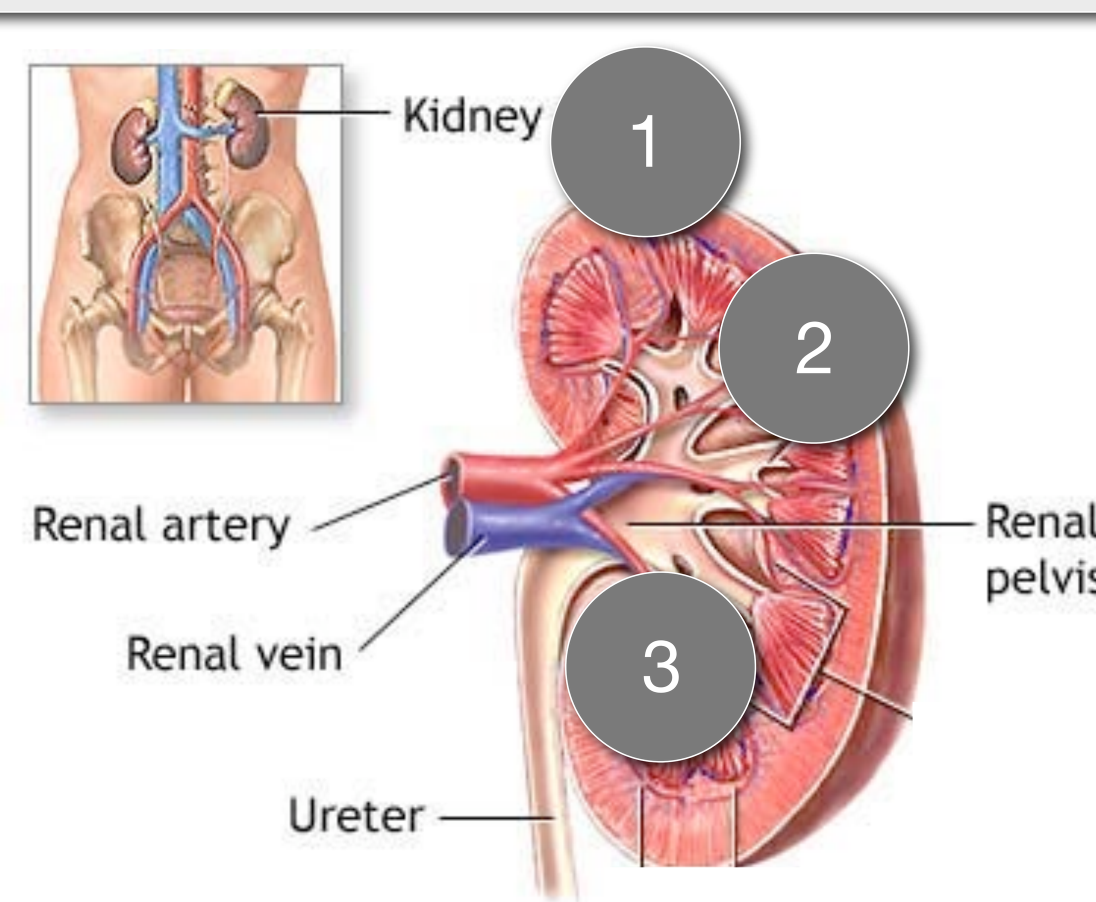
To ensure coagulation necrosis of the tumour temperatures should be maintained >100 C for 8 minutes.



Kideney Ablation ' Virtual Needle on MR images' Courtesy of Dr. Solbiati, Busto Arsizo Hopsital

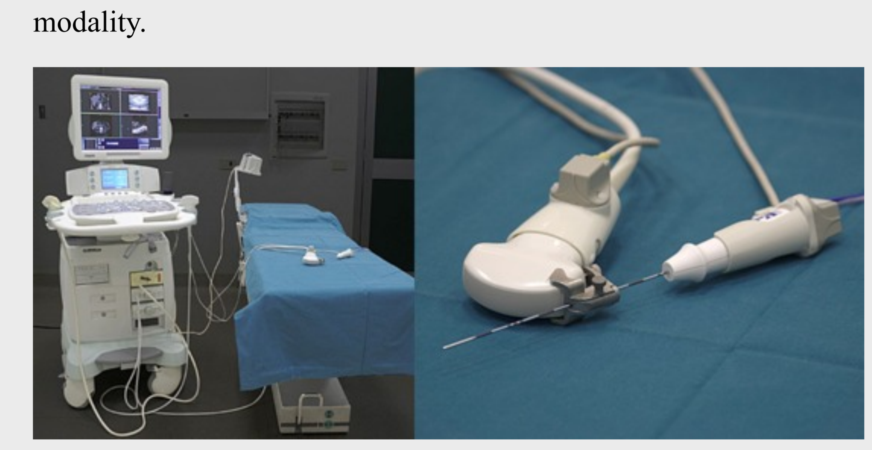
What is Fusion Imaging?

Fusion Imaging is a technique where dataset from different diagnostic imaging modalities are combined. In this study Fusion Imaging is where ultrasound (UL) is combined with Computed Tomography (CT) or Magnetic Resonance (MRI) using a magnet, a magnetic sensor and some advanced software. The CT/MRI scan is imported to the UL 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 UL and CT/MRI scan pictures can be seen either separated or overlapping. For this study we are using **Esaote MyLab™70 XVision with Virtual Navigator®**. Virtual Navigator is the absolute best Fusion Imaging technology on the market presently. With the newest software from Virtual Navigator we can with great precision mark a 3D area in the kidney for ablation. With the latest needle-guide software the virtual ablation needle can be seen exactly on the CT/MRI scan. In cases where an UL view is suboptimal because of colonic air close to a tumour, Virtual Navigator is an excellent guiding modality.



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.



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