Nanomaterials in Photoacoustic Imaging

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INTRODUCTION

PAI

Photoacoustic Imaging is a hybrid imaging modality which takes advantage of the photoacoustic effect. Ultra sound waves are generated by using laser pulses that cause thermoelastic expansion and contractions in the irradiated materials, which are then detected by calibrated ultrasound transducers. The main advantages of PAI are:

-ability to distinguish colors

-use of non-ionizing radiation

-greater imaging depth conventional optical imaging

Contrast Agent

We can use contrast agents to take advantage of PAI's ability to distinguish colors. Due to the unique optical properties of many nanomaterials, it is then possible to obtain high resolution images of specific regions of the body.

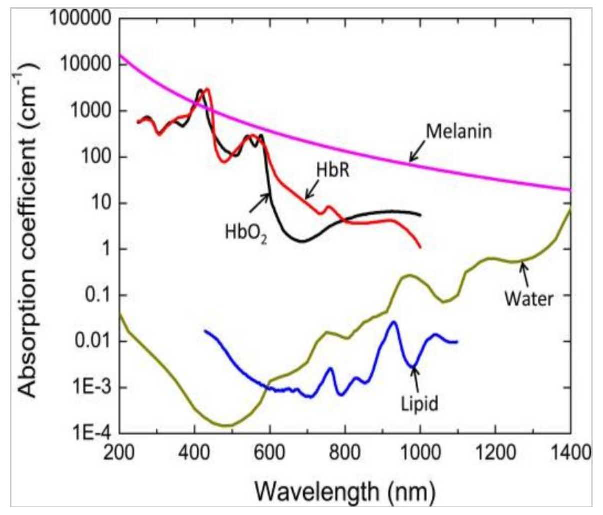

Figure 1: Note the photoacoustic absorption line for these endogenous contrast agents

AIM

The purpose of our experiment was to test the photoacoustic response of a nickel-based nanomaterial (provided by a separate company) for a 1064nm wavelength laser. 1064nm lasers are cheaper and widely available compared to other wavelength lasers. The ideal contrast agent would have these properties:

-good biocompatibility

-strong photoacoustic response

-fast clearance

-low manufacturing cost

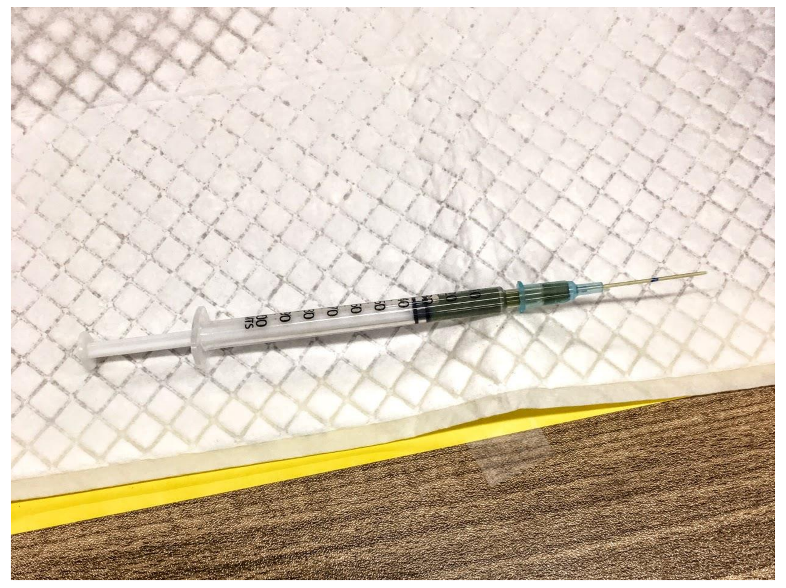

Figure 2: Nickel-based nanomaterial contrast agent in a syringe

METHOD

Sentinel Lymph Node Imaging In-vivo

Our lab imaged a rat's sentinel lymph nodes in-vivo using the nickel-based agent as contrast at two wavelengths: 800nm and 1064nm.

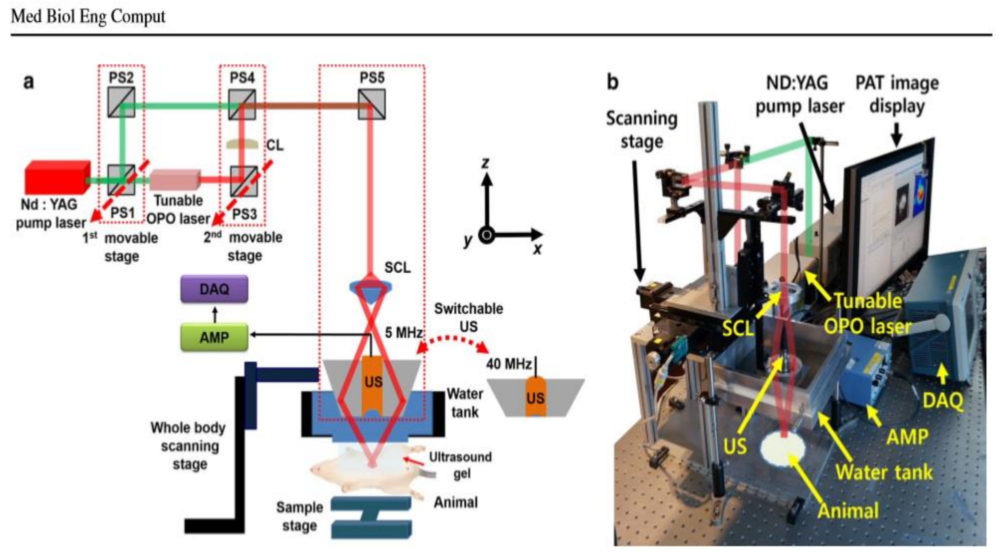

Figure 3: experimental setup with pictures and labels

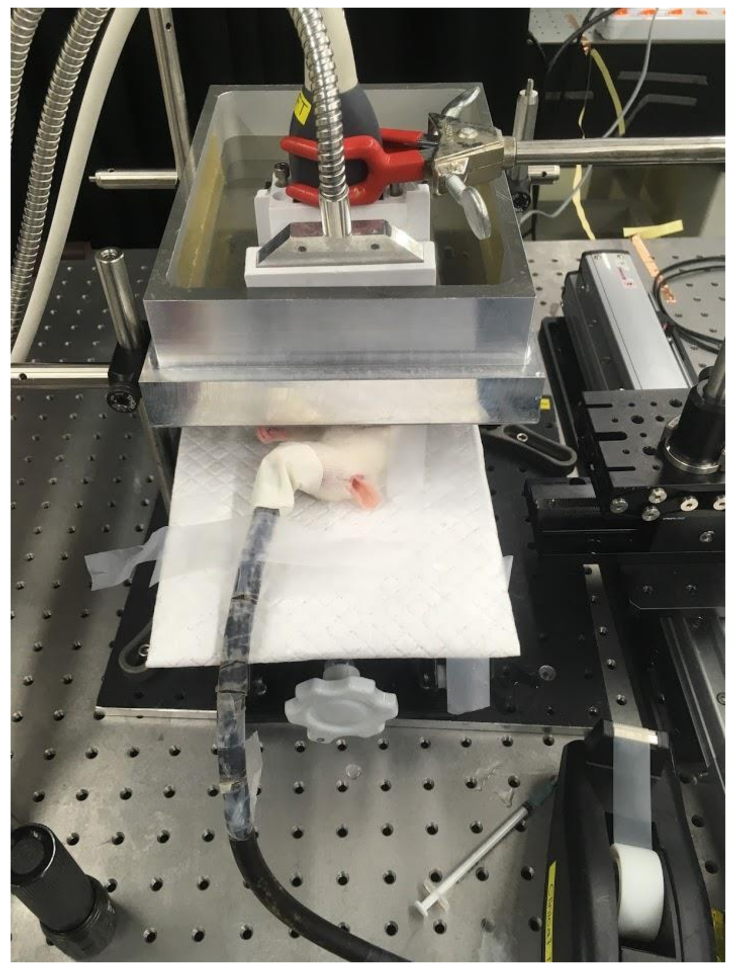

Figure 4: picture of our experimental setup. Nickel based agent was injected, then the rat was scanned at two wavelengths, 800nm and 1064nm.

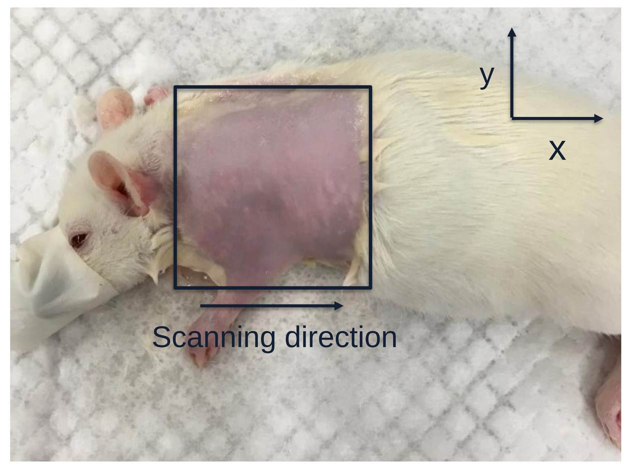

Figure 5: using hair remover to remove the rat's fur, we scanned from the upper to lower abdomen of the rat.

RESULTS

800nm Scan

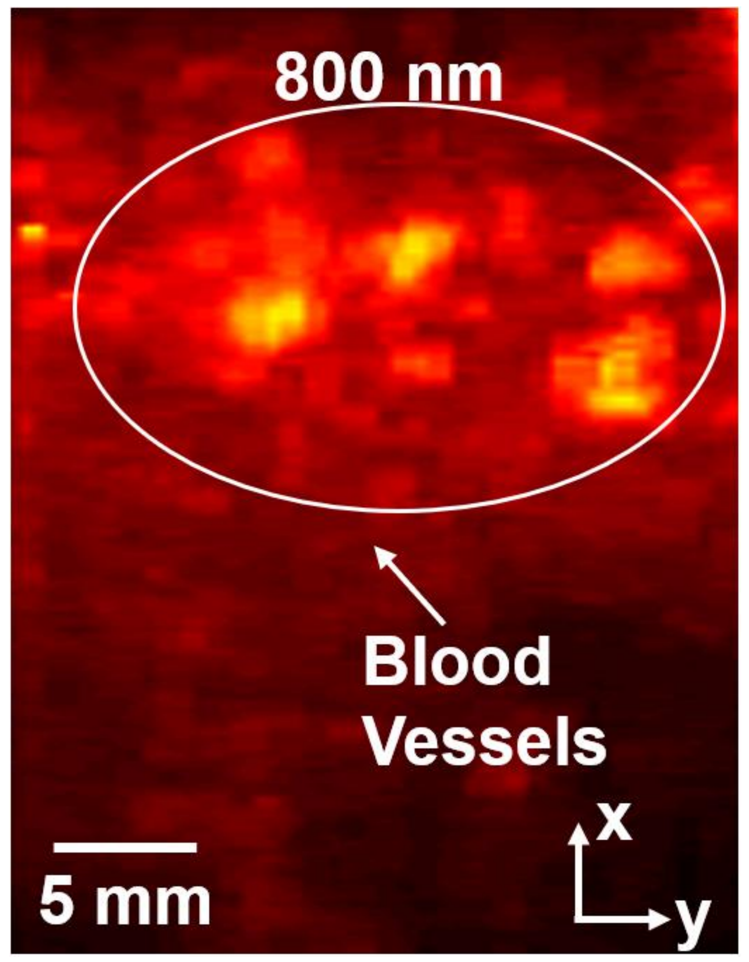

Figure 6: This scan was produced using the 800nm laser. Note the strong photoacoustic response of the blood vessels at this wavelength.

1064nm Scan

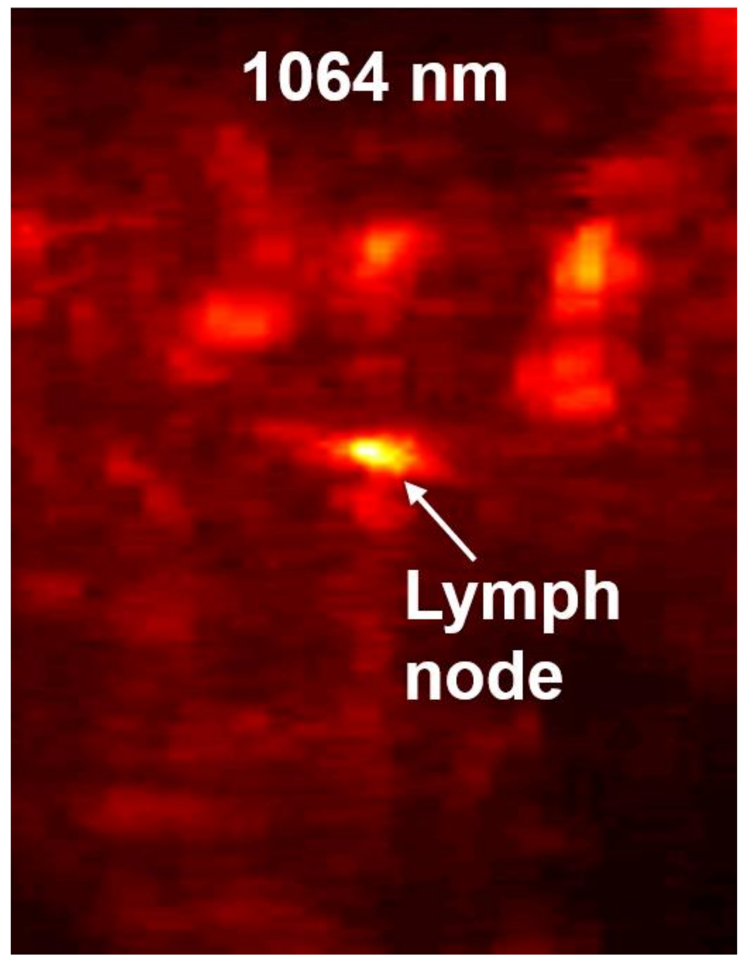

Figure 7: This scan used the 1064nm laser. Note that the blood vessels have a much weaker response, but we can now clearly see the lymph node thanks to our agent.

These results show PAI's ability to create high-resolution scans and distinguish color. When the 800nm wavelength is used, blood is used as an endogenous contrast agent and has a larger response, whereas the lymph node dyed with our contrast agent is invisible. However, when the 1064nm wavelength is used, the lymph-node can be seen very clearly.

CONCLUSIONS

Our nickel-based dye shows promising results. Because of the strong PAI response in the 1064nm wavelength, this dye can be used in conjunction with Nd:YAG lasers that have much wider availability than the variable wavelength lasers being used in the lab. Using this contrast agent may speed up the process of integrating PAI with the imaging technologies currently used in the medical field by reducing the cost of PAI setups. While further testing will have to be done regarding the biocompatibility and clearance of this agent, the initial results are promising.

Source: dhresrouce.com

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