ULTRA HIGH FREQUENCY ULTRASOUND CONTRIBUTES TO TRANSLATIONAL RESEARCH

A conversation with:

Dr Francesca IACOBELLIS: a specialist radiologist at Centre of Biotechnology of "A. Cardarelli" Hospital, Naples, explained how Ultra high frequency ultrasound imaging is enabling non-invasive morphological and functional assessment of biological structures in a preclinical environment.

Lots of imaging technology are widely used in preclinical research to provide, for example, cardiotoxicity, biomarker or drug expression as well as tumor behaviour. Ultra high frequency ultrasound is reliable, easy to access and perfectly adjusted to in-vivo longitudinal studies. Francesca explained the benefits of this technique.

I work as a radiologist at the Centre of Biotechnology of "A. Cardarelli" Hospital, performing preclinical research in Professor Roberto Grassi's group of the University of Campania "Luigi Vanvitelli", as part of my PhD studies. Ultra high frequency (UHF) ultrasound allows me to simultaneously obtain in vivo anatomical, functional, and physiological data in real time, with a resolution down to 30 µm. A big advantage of this technology is that I can perform non-invasive longitudinal studies of animal models, which is a more ethically acceptable way of undertaking preclinical research.

I have been using the VisualSonics technology since 2009, starting with cardiovascular imaging and moving on to abdominal applications. The Vevo system is particularly suitable for cardiovascular applications, offering exceptional quality images with high temporal resolution, which is ideal for the high cardiac frequency of small animals.

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B-mode ultrasound allows the heart morphology and function to be studied, complemented by M-mode assessment, and colour and power Doppler analysis of cardiac blood flow.

The Vevo system has played an important role in several projects, for example, the investigation of hamster models with limb-girdle muscular dystrophies, a condition associated with the gradual loss of muscle strength and progressive development of dilated cardiomyopathy. The animals were treated with gene therapy, employing adeno-associated virus vectors to deliver cDNA containing the lacking gene. UHF ultrasound was really helpful to monitor the effect of the treatment on cardiac function; treated hamsters showed preservation of the myocardial wall similar to that of wild type hamsters and only a slight reduction in myocardial contractility, while untreated hamsters displayed thinning of the ventricle wall and reduced myocardial contractility.

Another of our studies investigated mouse models of the lysosomal disease mucopolysaccharidosis, focusing on cardiac dysfunction as very little is known about this. We were able to observe that the test animals, in comparison to wild type mice, showed a marked increase in the left ventricular mass, as well as cardiac defects and a reduction in cardiac function. The quality of UHF cardiac images helps easy quantification and the reproducibility of measurement.

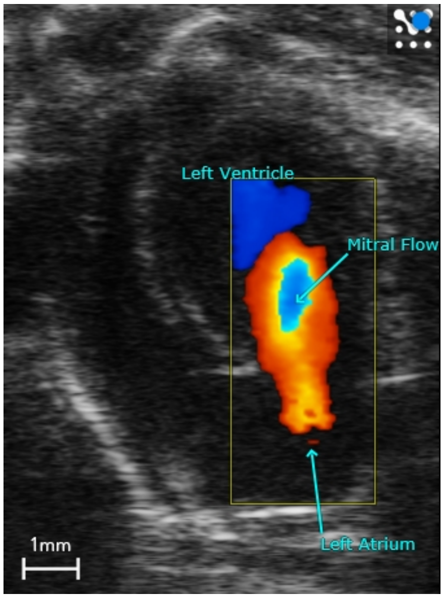
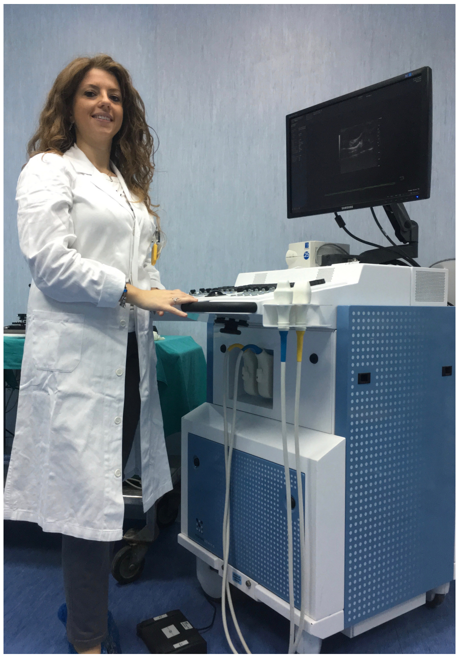


Fig: Apical 4 chamber view of the mouse heart with color Doppler indicating flow through the mitral valve.

I have also successfully used ultra-high frequency imaging to study the digestive system; it allows me to visualise vital organs and vessels, including the abdominal aorta, iliac branches, hepatic hilum, liver and bowel. In the case of a small bowel obstruction, the presence of extraluminal fluid can be an indication that the condition is worsening and requires surgery. Using UHF ultrasound, I was able to evaluate the onset and evolution of this condition in an animal model, following the intestinal changes over time to see how the bowel reacted to a blockage, as well as the increase in free fluid and the subsequent decrease once the obstruction had been removed.

My current project is looking at the morphological changes that occur in the renal parenchyma and other organs following haemorrhagic shock. An animal model with induced haemorrhagic shock was investigated, monitoring the blood pressure and obtaining ultrasound images before and during the shock period to explore changes in renal blood flow; ultrasound is ideal in this situation, where repeated in vivo measurements are necessary. The pathological data obtained confirmed that the model produced injury in the renal parenchyma, and so it can be used to assess systemic damage – not only in the kidney, but also in other organs – as well as to investigate biomarkers and test potential drug treatments.

More recently, new technologies incorporating photoacoustic imaging have become available with the Vevo LAZR-X. These multi-modal imaging systems combine UHF ultrasound with photoacoustics, and I am looking forward to exploring the fresh perspective that they bring to preclinical imaging studies. Like the Vevo 2100, they are sure to find many applications in the field.



About the Centre of Biotechnology at "A. Cardarelli" Hospital, Italy:
The Centre of Biotechnology at "A. Cardarelli" Hospital is a centre of biomedical research offering the most advanced technologies, enabling specialist in vitro and in vivo preclinical studies to be performed. In cooperation with the University of Campania "Luigi Vanvitelli", the centre founded the Metabolic and Structural Imaging Pole, an imaging facility equipped with advanced technology dedicated to preclinical imaging studies. Scientists at the imaging facility can train to use diagnostic imaging equipment and perform experimental research in different fields of study.