MASTS Fisheries Science Forum Grant (2015-16) Final Report (FSSG1)

Investigation of MRI as a method of detecting parasites in fishery products

Miguel Bao

Oceanlab, University of Aberdeen, Main Street, Newburgh, Aberdeenshire, AB41 6AA, United Kingdom.

School of Natural and Computing Sciences, University of Aberdeen, St. Machar Drive, Cruickshank Bd., Aberdeen, AB24 3UU, United Kingdom.

Introduction

Fish anisakid parasites that can be present in fishery products, especially the herringworm or whaleworm (*Anisakis*) and codworm or sealworm (*Pseudoterranova*), can cause important economic losses to the fishery industry and may represent a health risk for consumers. These roundworms can cause disease in humans who eat raw or lightly cooked infected fish products. The disease is called human anisakidosis and its severity can vary from mild to severe. The fish parasite *Anisakis* can also cause allergy in sensitized humans. To date, it is known that freezing and cooking properly the fish kill these parasites, thus preventing the disease. A number of parasite detection methodologies (visual inspection, candling, enzymatic digestion, ultraviolet illumination) have been used by the fishery industry, public health official inspectors and scientists to detect these anisakid nematodes in fishery products. However, these methods are invasive and destructive, which means that the fish sample has to be processed before it is possible to detect any parasite present.

Magnetic Resonance Imaging (MRI) is a widely used imaging technique for clinical diagnosis and research. MRI can also be used for studying the physicochemical properties and anatomical structure of fish, for example, the belly bursting process in herring or the fat measurement in fish muscle.

Objective and funding

The aim of this study was to investigate whether MRI can be used to detect anisakid parasites in the visceral cavity of whole unprocessed herring and anisakids present in fish muscle. MASTS awarded a grant of £1,000 to carry out the MRI investigations.

Methods

The study used a 4.7 T preclinical MRI scanner located in Medical Physics at the School of Medicine, Medical Sciences and Nutrition, University of Aberdeen.

First experiment - detection of *Anisakis* accumulation in the visceral cavity of whole herring

A whole herring was wrapped in a plastic bag and placed in the MRI system for scanning (Figure 1A).

Second experiment - detection of *Anisakis* in fish muscle

Fresh *Anisakis* parasites (n= 5) were extracted from the visceral cavities of two whole herring bought from a local supermarket (Aberdeen, Scotland). A piece of fish muscle approximately 8 cm long x 4 cm wide x 3 cm high was cut from a fish fillet (Figure 2A) and the parasites were introduced in the centre of the muscle piece with forceps. The sample was wrapped in a plastic bag and placed in the MRI system for scanning.

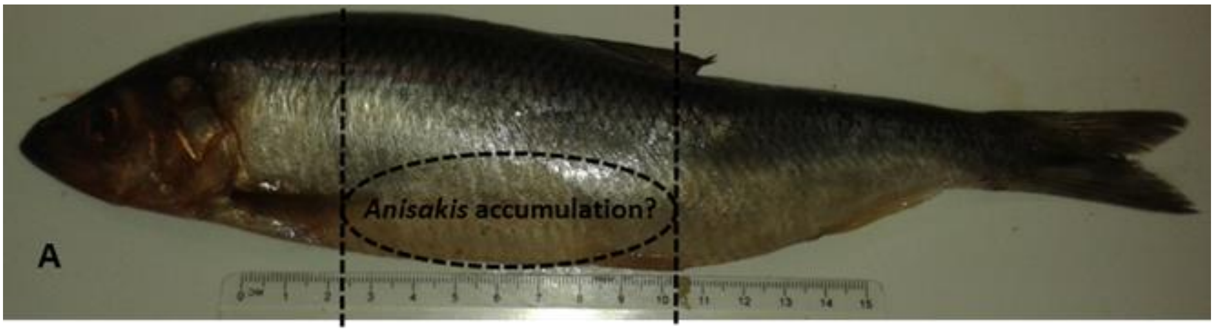
Third experiment - detection of *Pseudoterranova* in fish muscle

The muscle of a monkfish caught in the North Sea in the summer of 2015 was found infected by *Pseudoterranova* (codworm) during a routine parasite survey (Figure 3A). A piece of muscle containing the codworm was cut, wrapped in a plastic bag and placed in the MRI system for scanning.

Results

In this study, MRI demonstrated potential to (1) detect *Anisakis* accumulations in the visceral cavity of whole herring (Figure 1B), (2) detect *Anisakis* in fish muscle and follow their movements (Figure 2B and 2C), (3) detect *Pseudoterranova* infecting fish muscle (Figure 3B).

Figure 1. A. Photograph of the investigated herring. **B.** Sagittal MRI scan of the herring showing an *Anisakis* accumulation and internal organs. 1- Pyloric caeca, 2- stomach, 3- gonad, 4- swim bladder, 5- *Anisakis* accumulation, 6- muscle, 7- spine, 8- dorsal fin.



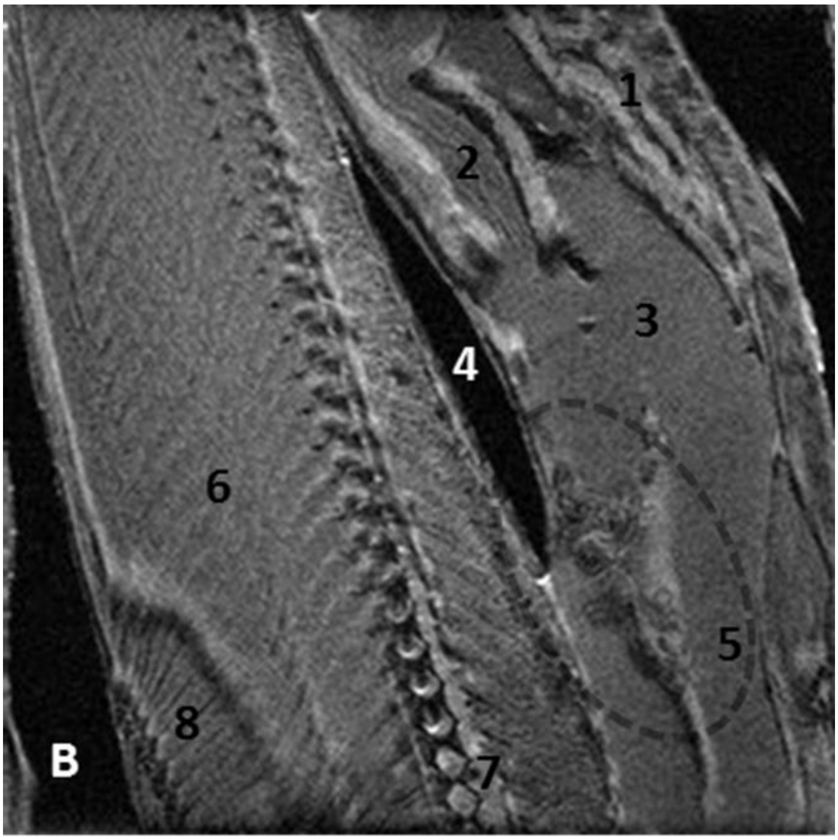


Figure 2. A. Piece of fish muscle in which the *Anisakis* parasites were introduced for MRI investigation. The two magnetic resonance images **B and C** were taken approximately 13 minutes apart and show an *Anisakis* larva moving inside the fish muscle (white arrow).

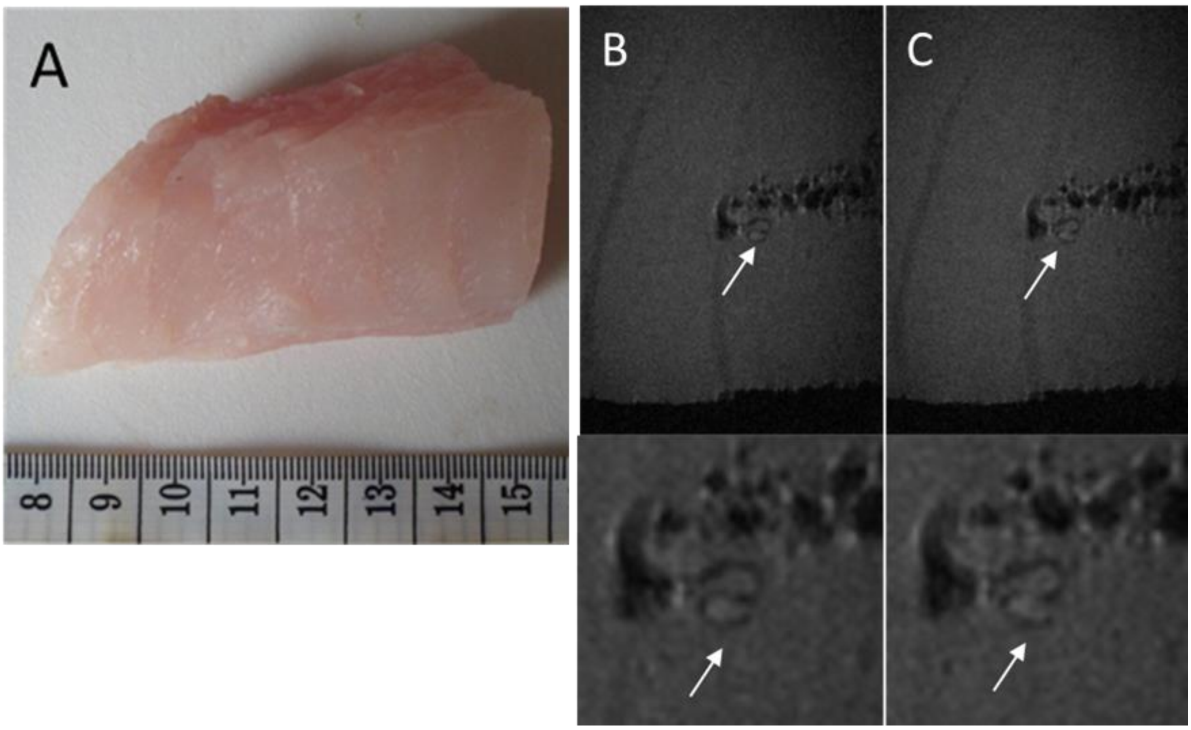
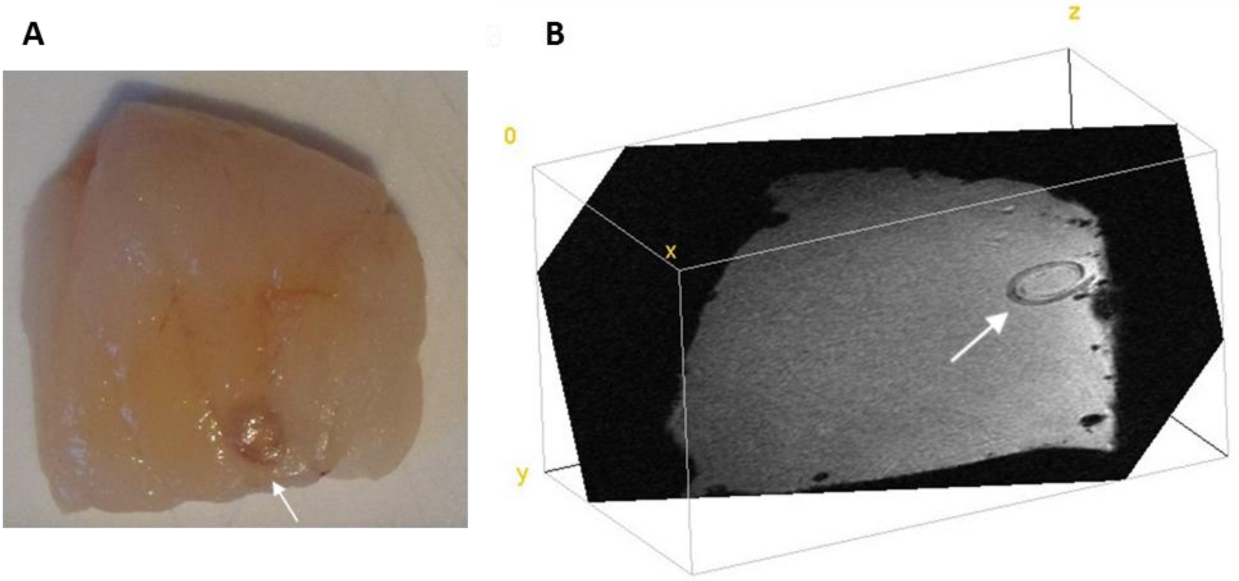


Figure 3 A. *Pseudoterranova* larva infecting fish muscle. **B.** 3D MRI scan showing the *Pseudoterranova* larva.



Conclusion

The study showed the potential of MRI for non-invasive and non-destructive detection of anisakids in whole fish viscera and fish muscle *in situ* (in a 3D environment). This type of imaging could give information on the behaviour of anisakids in the fish host and could have applications in fisheries surveys and screening of food products for anisakids. Because MRI is non-destructive, the product would remain marketable after inspection. It is also likely that MRI can be used to investigate other fish macroparasites.

References

BIOHAZ, E.P. on B.H., 2010. Scientific Opinion on risk assessment of parasites in fishery products. EFSA J. 8, 91. doi:10.2903/j.efsa.2010.1543

Cheng, J.H., Dai, Q., Sun, D.W., Zeng, X.A., Liu, D., Pu, H. Bin, 2013. Applications of non-destructive spectroscopic techniques for fish quality and safety evaluation and inspection. Trends Food Sci. Technol. 34, 18–31. doi:10.1016/j.tifs.2013.08.005

Collewet, G., Bugeon, J., Idier, J., Quellec, S., Quittet, B., Cambert, M., Haffray, P., 2013. Rapid quantification of muscle fat content and subcutaneous adipose tissue in fish using MRI. Food Chem. 138, 2008–15. doi:10.1016/j.foodchem.2012.09.131

Veliyulin, E., Felberg, H.S., Digre, H., Martinez, I., 2007. Non-destructive nuclear magnetic resonance image study of belly bursting in herring (*Clupea harengus*). Food Chem. 101, 1545–1551. doi:10.1016/j.foodchem.2006.04.007