Development of cardiac MRI for studying Zebrafish models of cardiovascular disease

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Introduction The zebrafish has emerged as an excellent model for cardiovascular research, in addition to low maintenance costs, the zebrafish has the remarkable ability to regenerate cardiac muscle following injury. In addition, many researchers are being attracted by the increasing availability of molecular, genetic and physiological research tools. However, unlike with mammalian models, live imaging of heart function remains challenging in the adult zebrafish[1]. Unlike embryos (<5day), the skin of adult zebrafish is non-transparent, i.e. pigmented and scaled, thereby precluding optical methods. We have explored the possibility of using MRI for in-vivo cardiac imaging of adult zebrafish, by implementing a retrospective self-gated cardiac sequence[2,3].

Method Experiments were performed on adult zebrafish (*Danio rerio,* fig 1A*)* using a 7T Bruker Biospec system, equipped with 4-channel phased array coil and micro-imaging gradients (1000mT/m). Pilot studies, acquired images from adult zebrafish cadavers , significantly immediately after death the heart of the zebrafish continues to beat for ~20 minutes, allowing the acquisition of the first ever Cine MR images of a beating zebrafish heart, see fig 1D, from the area highlighted in fig 1C. A retrospective self-gating cardiac sequences (Intragate) was used, where the signal from a navigator echo is used to retrospectively assign each line of k-space to a phase of the cardiac cycle[1]. This is particularly critical with regard to zebrafish, where normal ECG and respiratory gating would be extremely impractical. Parameter: Te 3.5ms; Tr 20ms; repetitions 300; FOV 1.2cm x 1.2cm; matrix 120 x 120; resolution 100um x 100um; slice thickness 0.35mm; scan time 6 minutes. Future studies will employ live fish, which will be scanned in a flow cell over a period of 20 minutes (fig 1B).

Results

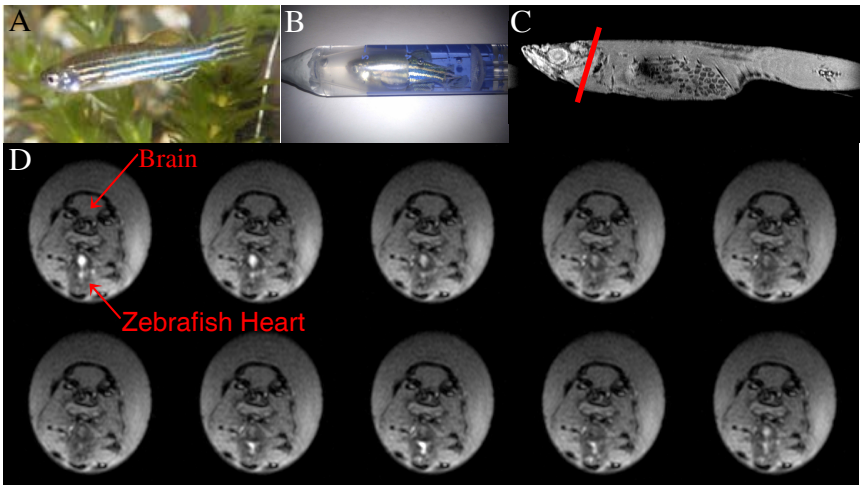

Figure 1.
A) Zebrafish (*Danio rerio*).
B) Flowcell for MRI.
C) Sagittal T2 image of female zebrafish (80x80x80 μm^3), note eggs in abdomen.
D) The 10 phases of Cine cardiac MRI acquire using retrospective self-gating. Slice corresponds to red slice in figure1C, with resolution 100 x 100µm with 350µm slice thickness.

Conclusion We have acquired the first Cine cardiac MRI of a beating Zebrafish heart. The difficulty of ECG and respiratory gating was overcome by employing a retrospective self-gating cardiac sequence. Given the rapid growth in the use of zebrafish for cardiovascular research, this may prove to be an important future application of cardiac MRI.

References

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