

## Effects of myoglobin oxygenation on oxygenation-sensitive cardiovascular magnetic resonance images: an in-vitro study

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**Funding Acknowledgements:** Local funds of the Department Anaesthesiology and Pain Medicine

**Background:** Haemoglobin (Hb) is an O<sub>2</sub>-binding transport protein with variable magnetic properties depending on its oxygenation status. Oxygenation-sensitive (OS-)CMR sequences (T<sub>2</sub>-, T<sub>2</sub>\*-mapping and bSSFP sequences) can discriminate the oxygenation status of Hb, thus Hb can be used as an intrinsic contrast agent (blood oxygen level-dependent (BOLD) effect). Myoglobin (Mb) also binds and transports O<sub>2</sub> in skeletal and heart muscle fibres and shares structural and functional similarities with Hb. The impact of Mb oxygenation on OS-sequences is yet unknown.

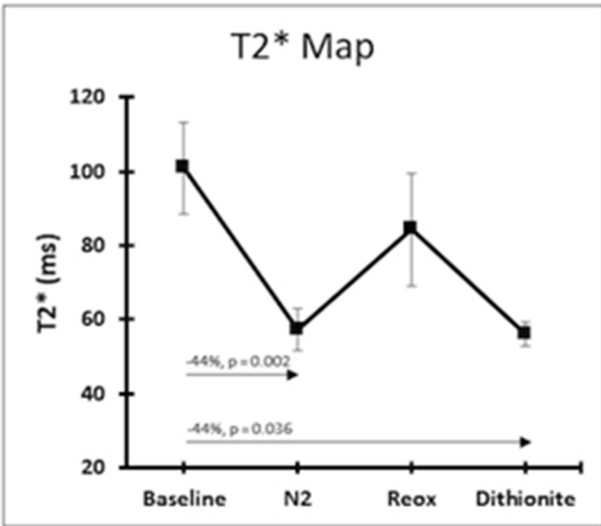
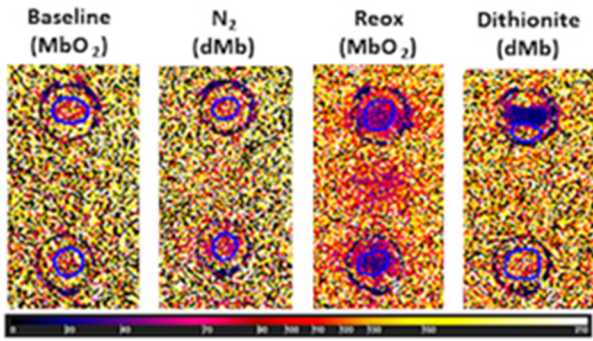
**Purpose:** The aim was to determine if Mb oxygenation of in-vitro samples has an impact on OS-images in clinically used CMR sequences.

**Methods:** Equine metMb powder was dissolved in water (14.4 mg/mL) and reduced to deoxygenated Mb (dMb) using excess sodium dithionite (Na<sub>2</sub>S<sub>2</sub>O<sub>4</sub>). With a desalting column the dithionite was separated from dMb, which then spontaneously oxygenated to MbO<sub>2</sub> at room air. Light-spectroscopy was used to confirm the presence of MbO<sub>2</sub>. Oxygen concentration from ambient air (20%) was reduced down to 0.4% to assure the patency of Mb. Ten samples were scanned in a 3T clinical MRI system (Siemens Magnetom PRISMA), all within a single imaging plane. A T<sub>2</sub> map (FLASH), a T<sub>2</sub>\* map and an OS-bSSFP sequence were modified to obtain a spatial resolution <0.5mm. 50 mL gaseous O<sub>2</sub> and N<sub>2</sub> were bubbled through the samples in the MRI and lastly dissolved dithionite was added to irreversibly deoxygenate to dMb. CMR images were acquired for each state.

**Results:** Light spectroscopy yielded the characteristic double peaked optical density (OD) maxima for MbO<sub>2</sub> (545nm and 580nm) with room air, which transformed into a single-peaked OD maxima curve for dMb (550nm) with decreasing oxygen concentration. As seen in the Figure, T<sub>2</sub> and T<sub>2</sub>\* were significantly shortened in the dMb samples compared to MbO<sub>2</sub> samples (MbO<sub>2</sub>: T<sub>2</sub> 180 ± 41ms, T<sub>2</sub>\* 101 ± 39ms) following deoxygenation with N<sub>2</sub> (dMb: T<sub>2</sub> 135 ± 23ms, T<sub>2</sub>\* 58 ± 18ms) and dithionite (dMb: T<sub>2</sub> 117 ± 14ms, T<sub>2</sub>\* 57 ± 10ms, \*p < 0.01). The bSSFP OS-CMR sequence showed no significant SI changes between Mb oxygenation states. Although T<sub>2</sub>\* maps were generally more artefact prone, they showed greater relative changes between the oxygenation states of Mb than T<sub>2</sub> maps. Conclusion: Using an in-vitro model, altering oxygenation states of Mb resulted in measurable changes in both, light spectrometry and oxygenation-sensitive CMR images, specifically T<sub>2</sub> and T<sub>2</sub>\* mapping. Our study indicates that the Mb molecule has a BOLD-like effect. It is now warranted to study its potential confounding or augmenting role in diagnostic OS imaging.

Abstract 22 Figure. T<sub>2</sub>\* and T<sub>2</sub>

T2\* Map CMR Images of Mb samples



T2 Map CMR Images of Mb samples

