Effect of nuclear magnetic resonance on the circadian clock and the hypoxia signaling pathway

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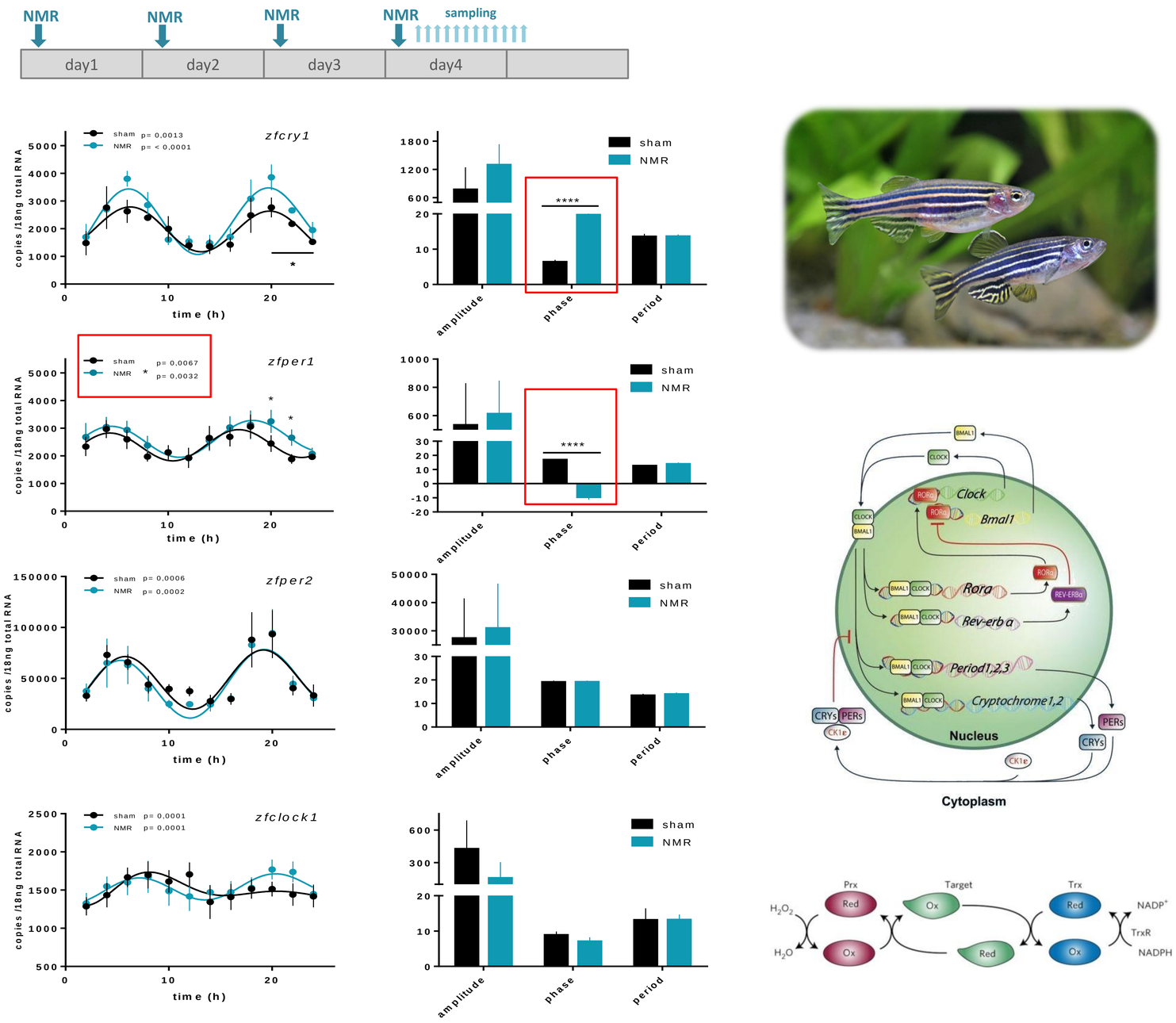
Introduction

Nuclear magnetic resonance (NMR) has been used as therapy for the treatment of human osteoarthritis and osteoporosis for more than a decade using the MBST® device developed by the MedTec company, but the effects of NMR on biological systems such as cells or organisms are still unknown. We therefore analysed the impact of NMR treatment on the zebrafish cell line Z3, a cell line which is well characterized in terms of circadian rhythmicity and hypoxic signaling. Both signaling pathways are highly conserved across the animal kingdom and play major roles in the development and progression of osteoarthritis.

Questions

Is there an effect of NMR on the circadian clock and the hypoxia signaling pathway?

What is the molecular key mechanism of NMR response?



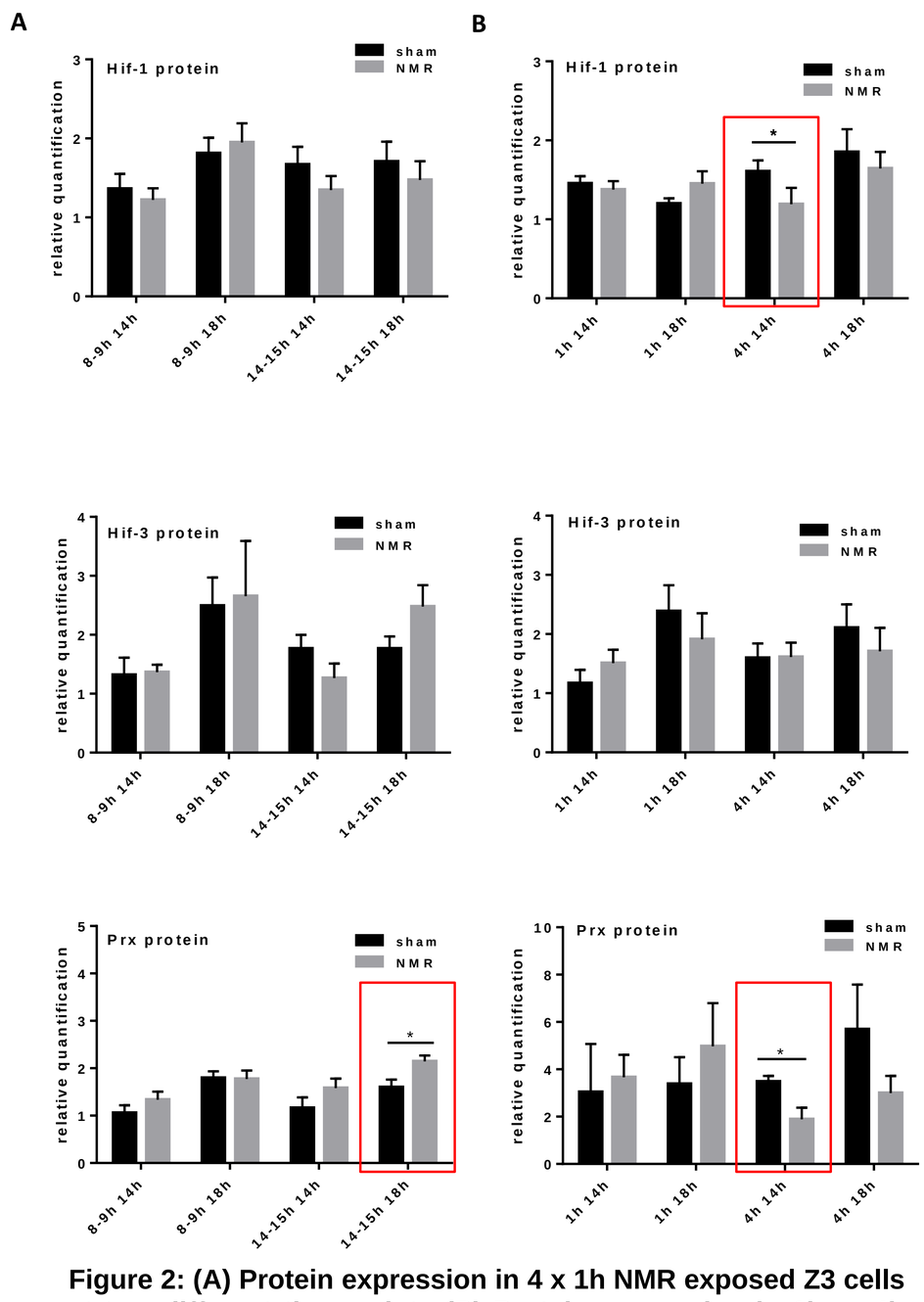


Figure 1: Gene expression in 4 x 1h NMR treated Z3 fibroblast cells; circadian rhythm over 24 hours; cryptochrome1 (cry1), period1 (per1), period2 (per2), and clock1; data are presented as mean values ± S.E. (N=4). * marks P< 0.05; **** marks P< 0.0001; cosinor analysis was performed using GraphPad Prism 6.01

Figure 2: (A) Protein expression in 4 x 1h NMR exposed Z3 cells at two different time points (B) Protein expression in 1h or 4h exposed Z3 cells; sampling at 14h and 18h. Bars represent mean values ± S.E. (N=6); * marks P< 0.05

Conclusion

The circadian rhythm of *cryptochrome1* and *period1* revealed a phase shift in the NMR group together with a significantly increased gene expression of *period1* which clearly demonstrates an effect of NMR on the circadian clock of Z3 cells. Protein expression of Peroxiredoxin-SO_3, an antioxidant for tuning the cellular redox status, and Hif1, the major regulator of hypoxia signaling pathway, was significantly altered after NMR exposure as well. In conclusion, NMR leads to a phase shift of the transcriptional clock and, due to the bidirectional interaction of both pathways also to altered Hif signaling.

Acknowledgements

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