Molecule that promotes muscle health when magnetised

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Associate Professor Alfredo Franco-Obregón and his team from the NUS Institute for Health Innovation and Technology examined how low amplitude magnetic fields may be used to enhance muscle metabolism. The images on the screen show the cells of two types of muscles—the blue fibres (left) are rapidly fatiguing muscles, the green fibres (right) are slowly fatiguing muscle, and the red fibres are considered transitional fibres. Credit: National University of Singapore

As people age, they progressively lose muscle mass and strength, and this can lead to frailty and other age-related diseases. As the causes for the decline remain largely unknown, promoting muscle health is an area of great research interest. A recent study led by the researchers from NUS has shown how a molecule found in muscles responds to weak magnetic fields to promote muscle health.

Led by Associate Professor Alfredo Franco-Obregón from the NUS Institute for Health Innovation and Technology (iHealthtech), the team found that a protein known as TRPC1 responds to weak oscillating magnetic fields. Such a response is normally activated when the body exercises. This responsiveness to magnets could be used to stimulate muscle recovery, which could improve the life quality for patients with impaired mobility, in an increasingly aging society.

"The use of pulsed magnetic fields to simulate some of the effects of exercise will greatly benefit patients with muscle injury, stroke, and frailty as a result of advanced age," said lead researcher Assoc Prof Franco-Obregón, who is also from the NUS Department of Surgery.

The NUS research team collaborated with the Swiss Federal Institute of Technology (ETH) on this study, and their results were first published online in *Advanced Biosystems* on 2 September 2020. The work was also featured on the cover of the journal's print edition on 27 November 2020.

Magnets and muscle health

The magnetic fields that the research team used to stimulate the muscle health were only 10 to 15 times stronger than the Earth's magnetic field, yet still much weaker than a common bar magnet, raising the intriguing possibility that weak magnetism is a stimulus that muscles naturally interact with.

To test this theory, the research team first used a special experimental setup to cancel the effect of all surrounding magnetic fields. The researchers found that the muscle cells indeed grew more slowly when shielded from all environmental magnetic fields. These observations strongly supported the notion that the Earth's magnetic field naturally interacts with muscles to elicit biological responses.

To show the involvement of TRPC1 as an antenna for natural magnetism to promote muscle health, the researchers genetically engineered mutant muscle cells that were unresponsive to any magnetic field by deleting TRPC1 from their genomes. The researchers were then able to reinstate magnetic sensitivity by selectively delivering TRPC1 to these mutant muscle cells in small vesicles that fused with the mutant cells.

In their previous studies, the researchers have shown that responses to such magnetic fields were strongly correlated to the presence of TRPC1, and it included the rejuvenation of cartilage by indirectly regulating the gut microbiome, fat burning and insulin-sensitivity via positive actions on muscle. The present study provided conclusive evidence that TRPC1 serves as a ubiquitous biological antenna to surrounding magnetic fields to modulate human physiology, particularly when targeted for muscle health.

Metabolic changes similar to those achieved with exercise have been observed in previous clinical trials and studies led by Assoc Prof Franco-Obregón. Encouraging benefits of using the magnetic fields to stimulate muscle cells have been found, with as little as 10 minutes of exposure per week. This tantalizing possibility, to improve muscle health without exercising, could facilitate recovering and rehabilitation of patients with muscle dysfunction.

Assoc Prof Franco-Obregón shared, "About 40 percent of an average person's body is muscle. Our results demonstrate a metabolic interaction

between muscle and magnetism which hopefully can be exploited to improve human health and longevity."

This study represents a milestone in the understanding of how a key protein may developmentally react to magnetic fields.

Metabolic health such as weight, blood sugar levels, insulin, and cholesterol are strongly influenced by muscle health. As exercise is a strong modulator of metabolic diseases through the working of the muscles, and magnetic fields exert similar benefits of exercise, such magnetism may help patients who are unable to undertake exercise because of injury, disease, or frailty. As such, the NUS iHealthtech research team is now working to extend their study to reduce drug dependence for the treatment of diseases such as diabetes.

"We hope that our research can help alleviate side effects by reducing the use of drugs for disease treatment, and to improve the quality of life of the patients," said Assoc Prof Franco-Obregón.

More information: Felix Kurth et al. Cell-Derived Vesicles as TRPC1 Channel Delivery Systems for the Recovery of Cellular Respiratory and Proliferative Capacities, *Advanced Biosystems* (2020). DOI: 10.1002/adbi.202000146

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