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Mitochondrial transplantation has been an emerging field of study as it can aid the aftereffects of cardiac arrest, also known as severe ischemia. Severe ischemia is a reperfusion injury that can occur when there is a lack of blood flow and oxygen in the body. Once restored, the supply of oxygen and blood flow can result in cellular and organ damage as well as cellular adenosine triphosphate. This study used both in vitro and in vivo studies on the mitochondria of lab rats who were oxygen deprived followed by resuscitation. After resuscitation, there were three groups: produced vehicle, frozen-thawed, and fresh viable mitochondria. Over the next 72 hours, the researchers will check the efficiency of the injected mitochondria through survival rates in the rats and will check to see if the donor mitochondria stayed inside the critical organs.

The results of this study showed that exogenous mitochondria from the brain once injected were absorbed by the cell. The neural cells began to mix with endogenous mitochondria. This proved to be very beneficial for the rats as it increased the survival rate within rats coupled with the advantage of likely having normal brain function. However, according to the study, fresh mitochondria were demonstrated to be more functional in this process compared to the other two groups. As it had four times more ATP production and a higher mitochondrial membrane potential compared to the frozen-thawed mitochondria. To illustrate, mitochondrial membrane potential helps with the synthesis of ATP, which can assist with many cellular functions and provide energy to the cell. In addition, during the 72 hours when fresh mitochondria were injected into animals, it improved the survival rate by 90.9%. In contrast, to the vehicle and frozen thawed mitochondria group they both only showed a 54.5% survival rate. The neurological function score and their body weights within the fresh mitochondria group was also significantly higher than the other two groups.

Furthermore, arterial lactate levels measure how much lactic acid is in the blood, and lactic acid is responsible for providing energy to the body when oxygen levels are low. So, within 15

minutes of resuscitation, arterial lactate levels increased within rats injected with fresh mitochondria. Pulmonary edema, also known as swelling inside the lung, was measured and found to be lowered when fresh mitochondria were inside the rat. To illustrate, the average wet to dry ratio for fresh mitochondria was 4.23 compared to vehicle at 5.70 and frozen thawed at 6.21. Due to 2 hours of monitoring there weren't any major differences in blood pressure or left ventricular ejection fraction, which is a measure of the heart pumping function. On the other hand, the fresh mitochondria group was observed at a higher arterial PH level and lower carbon dioxide levels in the blood. The glucose levels within animals were also lowered thanks to the fresh mitochondria as glucose is typically elevated after cardiac arrest. Lastly, cerebral perfusion, also known as blood flow to the brain, helps to deliver oxygen and nutrients to the brain and aids in brain function. The fresh mitochondria group increased blood flow to the brain by 107.7% whilst the vehicle group only increased by 77.5% and the frozen thawed group by 81.3%. These benefits prove just how significant and substantial fresh mitochondria are to cells.

Finally, the persistence of transplanted mitochondria within the body is different for each organ. Transplanted mitochondria can only remain in the body for one to 24 hours after injection. During this time, exogenous mitochondria were present in the brain, kidney, and spleen, but they were not detected in the heart, liver, or lungs. In conclusion, mitochondrial transplantation with fresh mitochondria massively improves the survival rate within animals and can aid with many cellular functions within animals. This research can also validate the use of a therapeutic approach to help with damaged cells after a stroke by transferring healthy cells.

References

Nishikimi M., Takegawa R., Kim J., Shoaib M., Aoki T., Murao A., Hayashida K., USA C., Shinozaki K., Wang P., Becker L. B., USA L., Yin T., Nakamura E., Miyara S. J., Endo Y., Kuschner C., & Choudhary R. C. (2023, March 16). *Exogenous mitochondrial transplantation improves survival and neurological outcomes after resuscitation from cardiac arrest - BMC Medicine*. BioMed Central, https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-023-02759-0

Ikhlas, M., & Atherton, N. (2023, August 14). *Vascular reperfusion injury*. Vascular Reperfusion Injury. https://www.ncbi.nlm.nih.gov/books/NBK562210/

Team, B. (2025, March 18). *Mitochondria membrane potential's role in energy production*. Mitochondria Membrane Potential's Role in Energy Production. https://biologyinsights.com/mitochondria-membrane-potentials-role-in-energy-production/

Vanbuskirk, S., & Begum, J. (2024, March 14). *Lactic acid blood test: High vs. low levels, normal range*. Lactic Acid Blood Test: What Your Levels Mean. https://www.webmd.com/a-to-z-guides/what-is-a-lactic-acid-blood-test