



B.O.N.E.S.

Bringing Osteo-cells to New Environments like Space

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Experimental Design

Introduction

- One of the most common health defects experienced by humans in space is a significant decrease in bone density.
- Due to there being minimal gravity in space, the body relies less on bearing weight on the spine and hips, therefore reducing the density of the bones. (1)
- Finding ways to prevent loss of bone density is crucial to increase the longevity of good health for astronauts, and could create the possibility of longer space missions with less risk.

Hypothesis

If we can find ways to prevent bone loss in mice through harm reduction and possible stem cell therapy, we can apply the outcome to humans who experience decreased bone density in space.

References

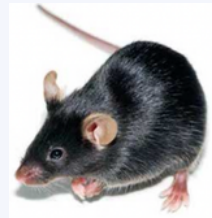
National Aeronautics and Space Administration (NASA). Risk of Spaceflight-Induced Bone Changes. NASA, 16 May 2025 (1)

Arjmand, Babak, et al. Prospect of Stem Cell Therapy and Regenerative Medicine in Osteoporosis. *Frontiers in Endocrinology*, vol. 11, 2020, article 430 (2)

National Aeronautics and Space Administration. Counteracting Bone and Muscle Loss in Microgravity. NASA, 1 Dec. 2023, (3)

Control Group

Mice Strain: C57BL/6



- Matured mice (about 12 weeks), male and female with regular diets.
- Will be placed in a Random Positioning Machine to experience microgravity conditions each day for a set duration of time.
- Bone density will be recorded afterwards via DEXA scan.
- Will not receive mesenchymal stem cells.
- Bone density will be recorded and compared to that of experimental group, three months after said group' stem cell administration.

Experimental Group

Mice Strain: C57BL/6

- Matured mice (about 12 weeks), male and female with regular diets.
- Will be placed in a Random Positioning Machine to experience microgravity conditions each day for a set duration of time.
- Bone density will be recorded afterwards via DEXA scan.
- Will receive mesenchymal stem cells intraosseously after multiple RPM trials that show significant bone density loss. Only one dose will be administered, which will be approximately two million (0.02 mg) of mesenchymal stem cells.
- Cell regrowth will be observed the following three months after administration.

Research

- Recent studies have shown that patients with osteoporosis, a condition where individuals encounter unhealthy amounts of decreased bone density, have experienced increased bone density due to cell regeneration through mesenchymal stem cells (2).
- The goal of stem cell use is to regenerate osteocytes that have significantly decreased, which have been the result of decreased bone density. Because Astronauts experience symptoms of osteoporosis, stem cells can be used remedially to increase bone health after a space mission (2).
- The critical point in which decreased bone density becomes a concern is based on a DXA scan, which is a bone density test. Scores between 0 and -1 indicate normal bone density, -1 - -2.5 indicates osteopenia, and anything below a -2.5 means an individual has osteoporosis. On average, humans lose about 1-1.5% of their bone density every month in space, which is comparable to two decades of aging.
- Current strategies to maintain bone health in space include diets that are high in calcium and vitamin D, as well as extensive physical training to prepare the body for the drastic environmental changes. Although helpful, these strategies are not 100% effective at counteracting reduced bone density in space. (3)

Conclusion

It is important for more studies regarding stem cell therapy to be done to conclude whether it is ethical, safe, and progressive for humans to use, especially to aid reproduction of osteoblasts. If humans continue to fulfill long-term missions in space, it is necessary to circumvent any health defects in the most efficient way possible.

Future Direction

- In future experiments, it is important to include the function of osteoclasts overtime, as they play a key role in discarding dead osteoblasts, rather than producing them.
- Because stem cell therapy is such a new technological advance in science, there is little understanding of potential adverse side effects from various types of stem cells.
- There is still very limited information on whether stem cell therapy must be conducted continuously with multiple trials, or if it simply requires a single dose.