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# Spine and Microgravity

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**Abstract:** Due to the micro gravitational atmosphere in space, astronauts are deprived of spinal loading patterns. Incremental gravitational forces act on astronauts as they return to Earth's atmosphere. Prolonged removal of gravitational loading can lead to spinal lengthening via postural changes and increased compressive disc loads. Thus, axial load of the spine was often stabilized along the lumbar lordotic alignment and when altered, mechanical pathologies likely arose. The human spine is supported by multiple muscles: multifidus, lumbar erector spinae, quadratus lumborum, abdominal wall muscles, and psoas. Because of unnatural unloading of the spine in microgravity, the supporting trunk muscles can become atrophied. The main objective of this study is to evaluate the amount of damage that the spine goes through in space while in a microgravity environment. Also, we are in the process of suggesting the best technique that would help astronauts to protect their spine from any damaging effects in space.

*Keywords:* disc degeneration, space, astronauts, spinal unloading

## 1. Introduction

An imperative to helping maintain spine health with countermeasures of space travel remains an important topic for space science. Due to the micro gravitational atmosphere in space, astronauts are deprived of spinal loading patterns. As astronauts spend prolonged periods of time in space, their spinal health can be at risk and there is also significant risk involved with returning to Earth's atmosphere (Gordienko et al., 2019; Sayson et al., 2013). Incremental gravitational forces act on astronauts as they return to Earth's atmosphere. Sensory organs related to stretch and load have been observed. For instance, Bailey and colleagues (Bailey et al., 2022) found half of 12 astronauts studied pre-post space flight for 6 months experienced lumbar disc profusion, decreased muscle quality of the multifidus, and decreased lean muscle mass. Additionally, they found that a decreased range of motion was observed in flexion and extension of the lumbar spine, as well as fixed end plate pathology in the upper lumbar spine. Thus, returning to Earth was a factor of low back pain (LBP) as the muscles that support the lumbar spine were not properly maintained while in space.

## 2. Background

Herniated discs due to torn nucleus pulposus is a repeated observation of research on astronauts, especially while returning from the mission (Hargens & Waterpaugh, 1992; Samsom & Hargens, 2008). The precise pathology of low back pain during spaceflight is not established. While the loss of muscle cells and disruption of bone growth is established, the chronological pathology that happens on the spine in microgravity is still under question (Sayson et al., 2013). In addition, the spine may elongate in microgravity as compared to zero gravity, as evidenced by Andreoni et al., 2000. The same study also reported a 4+-0.27% spinal elongation when subjects were exposed to microgravity. Studies have evidenced that complete bed rest following extended inactivity of the spine increases the disc size up to 2 years (Belavy et al., 2016; Belavy et al., 2022; Bailey et al., 2018). Prolonged bed rest reduces the range of motion (ROM) and increases spinal swelling. Mechanistic study of this phenomena on rats, introduced to low level high frequency mechanical signals, has demonstrated maintenance of the functionality of spinal motion segments.

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## 3. Future plans

Since the spine goes through complete unloading in absence of gravity, the spinal shape is disrupted while in space. Based on this fact, we conclude that exercises or stretches that will reduce the unloading of the spine would be focused on. We are experimenting with McKenzie stretches that can be done in standing positions with or without stable footing. We experimented with the Lumbar Motion Monitor (LMM) to determine the trunk position while doing McKenzie Method stretches and found out that the twist acceleration, twist velocity, and lateral velocity during stretches improved the spinal posture of the participants. These numbers, when compared to healthy populations in reference data during normal tasks, provide a comparison of how much potential the McKenzie stretch method could have on Lumbar spine health. This study is ongoing.

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