Jeffrey Willey

A research focus of my laboratory is to characterize the cause and extent of long-term musculoskeletal injuries caused by radiation therapy (RT). As cancer survivorship improves, preventing late treatment-induced complications is becoming a great concern. Severe musculoskeletal complications are among the most frequent occurring and severe of these late complications. Our group works with radiation oncologists, radiation physicists, and orthopaedic surgeons to develop cancer-treatment specific animal models, and test preventative measures that hopefully will translate to the clinic.

Radiation-induced bone fracture is a relatively common late complication of cancer treatment. For example 30-40% of patients receiving high dose per fraction radiation therapy (SBRT) for primary lung cancer experience a rib fracture within 3 years. The risk of hip fracture in postmenopausal women treated for cervical, rectal, and anal cancers is greatly increased (Relative Risk: 1.66, 1.65, and 3.14) five years after RT, and ~20% of women from this demographic will die within a year of hip fracture. Thus RT-induced skeletal fractures at directly irradiated locations can result in substantial patient morbidity, loss of independence, and increased mortality.

Our ongoing research projects are currently i) developing an imaging algorithm (from conventional CT scans) that will characterize the extent and progression of bone loss and deterioration during the course of RT and at both short and long-term follow-up, and ii) a predictive indicator that will identify which patients are most at-risk for developing a RT-induced fracture. Additionally, we are testing novel therapeutics to identify well-tolerated agents that can prevent radiation-induced bone loss, with the intent of translating these agents into the clinic. These agents include Muscadine Grape Extract (working with Drs. Ann Tallant and Peg Gallagher from Hypertension), and small molecule inhibitors of Endoplasmic Reticulum stress.

NASA-Funded Research

Maintaining musculoskeletal health during long-duration spaceflight is crucial for ensuring both mission success and full skeletal recovery upon returning to earth. The damaging effects of microgravity on the soft tissues of the knee and hip joints remain undefined. There is considerable evidence that soft tissue damage in these joints can occur with reduced loading. The degradation of the hip and knee joint during prolonged spaceflight has the potential to cause arthritis, debilitating joint pain, impaired mobility, and reduce the astronaut’s quality of life upon return to earth. Our laboratory is funded by NASA to investigate how unloading during spaceflight can i) lead to overall degradation of the knee and hip joints, and ii) to identify if this degradation can be recovered using aerobic and resistance exercise countermeasures. To address these aims, we send mice to the International Space Station for a period of 30 days, and then identify both joint damage and recovery after landing, as well as monitor alterations in gait that are indicative of joint injury. Below: Mission Patch from my most recent Spaceflight experiment to the International Space Station with NASA and SpaceX.