

AbstractID: 10386 Title: In vivo proton beam range verification using spine MRI changes

**Purpose:** Uncertainty in the location of the distal dose edge is one of the main concerns about proton therapy. It leads to cautious treatment plans that partially neutralize the dosimetric advantage of protons. Vertebral bone marrow responds to radiation with fatty replacement that is visible on post-treatment MRI. This presents a unique opportunity to visualize radiation effects *in vivo*. We have developed a method that uses spine MRI changes to precisely localize the distal dose edge in spinal proton radiation patients.

**Method and Materials:** We carefully registered treatment planning CT scans and follow-up T1-weighted MRI scans from 10 proton spinal radiation patients. A radiation dose-MRI signal intensity curve was created using the lateral beam penumbra in the sacrum. This curve was then used to quantitatively examine possible systematic or spatially varying proton range errors.

**Results:** In the lateral penumbra there was a gradual increase in signal intensity with higher dose throughout the full dose range of 0-37.5 Gy. In the distal dose fall-off region, the beam appeared to penetrate farther than planned in the central part of the vertebral bodies. The mean overshoot in five patients was 2.71 mm (95% confidence interval 1.13-4.28 mm). These errors are probably not clinically significant with current treatment planning procedures.

**Conclusion:** We have demonstrated *in vivo* proton range verification based on post-treatment spine MRI changes. Our analysis indicates that if range errors occur in spine treatments, their magnitude is at most a few millimeters in the majority of patients. It may be possible to extend our technique to MRI sequences that show early bone marrow changes. It could then be used for adaptive modification of spine radiation plans in order to reduce radiation dose to bone marrow and other normal tissues.

**Conflict of Interest (only if applicable):** None