Purpose: To develop a system using piezoelectric pressure sensor arrays in a radiosurgery/radiotherapy environment to accurately map patient motion with sufficient precision to supplement or replace portions of standard image-based patient positioning techniques.

Materials and Methods: An inexpensive, noninvasive, non-ionizing continuous patient tracking system would benefit the accuracy and efficiency of treatment delivery in cranial radiosurgery, as well as other modes of radiotherapy. We assessed the ability of piezoelectric pressure sensors placed under a standard CIVCO head sponge to detect patient movement. Multiple FlexiForce (Tekscan, Inc) sensors (0.2 mm thick, 25 lb pressure range) were attached to the plastic support structure of the head sponge such that the sensors bore the entire weight of the head. Volunteers were used to provide realistic clinical motion. The volunteers were instructed to rotate their heads ±5 degrees from a rest position. Visual markers were used to reproducibly align the volunteer at -5, -2.5, 0, 2.5, and 5 degrees. For each position, the response of each sensor was measured and recorded. In separate measurements, each FlexiForce sensor was tested for radiation durability by measuring sensor response to the application of known weights between delivery of multiple 25 Gy fractions.

Results: Sensor measurements with volunteers demonstrated a linear response to rotation angle and a clear indication of direction of motion. Sensor response to known weights after 100 Gy was found to vary less than 1.3% from measurements prior to irradiation, which is below than the manufacturer-specified reproducibility of the sensors (2.5%).

Conclusions: Preliminary results indicate the piezoelectric pressure sensors can reliably track small cranial movements in a radiosurgery environment. Application of this technology can potentially improve treatment precision by alerting therapists to inter-imaging motion, and treatment efficiency by potentially reducing the frequency of radiograph-based imaging.