Commissioning of a clinical chair for patients treated in the seated position using an inclined beam line treatment room.

**Purposes:** A chair, coupled to a robotic patient positioning system (PPS) was manufactured to treat beam angles of 360-degrees around an intracranial tumor using the two gantry angles of a proton incline beam-line (IBL) system at the ProCure Proton Therapy Center in Oklahoma City. Treating patients in the seated position as accurately and efficiently as treating patients on a treatment table was a requirement of the chair development project. From a clinical perspective, the seated position should not increase treatment times or increase the number of X-ray images. The essential functions of the system, which includes isocentric rotation and a weight-sagging-correction algorithm for positioning patients in the seated position, were commissioned.

**Methods and Materials:** The Chair design incorporated a down-slope arm (Figure 1) to achieve the desired beam-line height. This design restricted the top rotation of the PPS to 125 degrees. In order to address this limitation, five indexed positions of the seat-base-plate (SBP) were implemented to achieve a 360-degree rotation (Figure 1). An in-house developed optical tracking system using a six degree-of-freedom camera (Figure 2) was used to align the treatment room coordinate system with the chair coordinate system at all SBP positions. Furthermore, this optical tracking system quantified the sagging effect due to both the height and weight of a variety of patients (Figure 3).

**Results:** The optical tracking system has accuracy of 0.1 degree and 0.1 mm. This system aligned the SBP axis to room rotational axis within 0.1 degree. Then, as the treatment chair SBP was rotated, a residual displacement resulted from the precession of the chair coordinate system around the room coordinate system. This precession was found to be an ellipse with long axis of 2.0 mm and short axis of 1.0 mm. An additional 0.75 mm deviation occurred when rotating SBP and PPS axes. Sagging tilt of 0.6 degree was found on the SBP for the home position for every additional 162 lbs load. This resulted in a 1.1 cm shift (0.65 cm forward and 0.87 cm down) for an isocenter 90 cm away from the SBP plate.

**Conclusions:** While using an in-house developed optical tracking system, we studied the relationship between the treatment chair coordinate system and the room coordinate system. The overall maximum displacement of treatment chair system from isocenter is within 3.0 mm with known sagging characteristics. This characterization is essential to reduce the total treatment time and limited the number of X-rays required for accurate patient alignment in the seated position.