Purpose: To develop an accurate and efficient single-marker-based optical tracking system to enhance patient safety and quality of care in radiotherapy.

Methods: The optical tracking system consists of a Polaris camera as well as in-house software. The camera is mounted inside the treatment room and detects the location of a single infra-red (IR) reflective marker affixed on patient skin in real-time. The tracking system safeguards patient from treating wrong sites by comparing real-time marker position to the position predicted by virtual simulation, which is independent of couch or any indexing system. The deviation of marker position is shown in color (red or green) to indicate accuracy of patient positioning. The system works in concert with record-and-verify (R&V) system to further enhance patient safety and smooth clinic work flow. Marker information matching the patient under treatment is automatically loaded by the tracking system when a setup or treatment field is loaded in R&V. In non-coplanar treatment, the system automatically adjusts expected marker coordinators by accounting for each beam's couch angle extracted from R&V.

Results: Accuracy of the developed tracking system on a pelvis phantom has been verified against a CBCT system to be within 1.0 mm for coplanar treatment. In non-coplanar treatment, uncertainty of the system increases as the distance of the marker relative to treatment isocenter. The system precisely and automatically loads in patient and marker information for each beam, in concert with our R&V system.

Conclusions: We have developed an accurate and efficient single IR marker-based optical tracking system for patient treatment position verification. It significantly enhances patient safety with streamlined clinic work flow. The system can be readily upgraded for high-precision radiotherapy with the use of multiple markers (>4).