Purpose: Stereotactic body radiotherapy (SBRT) can be delivered by a linac machine using multiple beams or a Cyberknife machine. The Cyberknife-based SBRT usually allows greater dose conformity to the tumor target and reduce normal tissue toxicity. However, it requires much longer treatment time. This work explores the potential impact of such prolonged delivery times on treatment outcome.

Methods: The tumor-control probability (TCP) utilizing an extended linear-quadratic (LQ) model, which accounts for sublethal damage repair and clonogen proliferation, was used to calculate the cell-killing efficiency of clinical SBRT plans for 30 patients. LQ parameters derived from compiled clinical data for lung cancer ($\alpha=0.31$, $\sigma_\alpha=0.062$, $\alpha/\beta=10$ Gy, $Tk = 21$ d, $Td = 3$ d and a 0.025 s$^{-1}$ repair constant) were used to compute changes in the TCP due to prolonged delivery time associated with Cyberknife-delivery. The dose-volume histograms were obtained from actual SBRT plans using 12 Gy x 4 or 10Gy x5 fractions. The impact of delivery time at 10, 50, and 70 min on TCP were studied for all 30 patients. For a few typical patients with small, intermediate, and larger tumors, the TCP was calculated for a range of delivery time from 5 to 100 min.

Results: Our calculations showed that an average 99.8% of TCP was reached for most of the patients, if 10 minute delivery time was assumed, except for a few patients with large or multiple targets. By increasing treatment delivery time from 10 to 50 and 70 minutes, the TCP decreased by an average of 3% for most of the patients. Significant decrease was found for those same patients with larger tumors or multiple targets, with the TCP values in the 67% range.

Conclusions: The delivery time may have a significant impact on Cyberknife-based SBRT treatment outcomes for patients with larger or multiple tumors.