Purpose:
Normal tissue dose tolerance for hypofractionated radiotherapy is under active investigation. Previous radiation increases the complexity of determining the dose limits. We developed a software tool to optimize CyberKnife treatment planning for patient specific dose tolerances using the linear quadratic (LQ) model to derive biologically effective doses (BED) and to correlate these findings with observed toxicities.

Methods:
A program was written in Visual Basic using LQ model to estimate the normal organ BED tolerance for hypofractionated radiotherapy. Total tolerance BED was derived from the literature on conventional fractionated radiotherapy. For patients who previously received radiation from other modalities and fractionation schemes, prior doses were converted to equivalent BED and subtracted. Based on these calculations, physicians set dose constraints for organs at risk (OAR) to optimize the treatment plan. Plan re-optimization was required until the plan dose was less than 90% of the dose constraint for each OAR. 259 consecutive patients treated with CyberKnife radiosurgery at our institution since 2007 to 2010 were retrospectively reviewed. Treatment related toxicities were evaluated according to CTCAE for 208 out of 259 patients who had available follow-up data.

Results:
Guided by this software tool, plan re-optimizations were routinely performed for most patients (193/208 patients or 93%). 60 patients (29%) received previous radiation treatment. High grade early toxicities were observed in 4 patients (4 or 1.9% in grade 3, no grade 4 or 5). All high grade toxicities were related to the OAR identified in the planning process.

Conclusions:
This software provides an essential tool to appropriately optimize hypofractionated radiotherapy. The LQ model and BED dose evaluations appear to be a safe method to obtain normal tissue tolerances for these patients, with toxicity rates comparable to conventional fractionation. The BED subtraction method properly set the optimization objectives for patients treated with different fractionation schemes.