Purpose: Evaluate the tumor coverage and dose to organs at risk (OAR) from proton patch field irradiation using over-irradiate and under-irradiate modes.

Methods: Proton patch field configuration is a powerful treatment planning tool used in proton therapy to spare OAR. In this beam arrangement a shoot through beam is used to irradiate a large portion of the tumor and one or more patching beams are used to treat rest of the tumor. The patching beam is distally stopped at the lateral edge of the shoot-through beam. For such complex beam arrangements a treatment plan done with nominal uncertainties may not be adequate to assess tumor coverage and risk to critical structures. The beam range and patient density uncertainty increase or decrease penetration of a proton beam and position uncertainty expands or contracts the irradiation area by shifting aperture and compensator during treatment delivery. In addition to nominal plan, we used the over- and under-irradiation mode available in our treatment planning system to simulate two extreme circumstances during the treatment delivery. The nominal, over-irradiate and under-irradiate plan are used to evaluate tumor coverage and estimate the dose to OAR with the patch field irradiation.

Results: In proton patch field irradiation the uncertainties can adversely affect tumor coverage and the OAR. Over-irradiate and under-irradiate mode create dose distributions under extreme but likely coincidence of uncertainties. Using these dose distributions in conjunction with nominal dose distribution can help us evaluate a plan more realistically, and rethink the dose constrains on critical structures.

Conclusions: In addition to nominal dose calculation, the over-irradiate and under-irradiate mode of dose calculation should be used to evaluate complex proton plans, especially those involving patch fields.