Utilizing a hybrid optimizer to improve dose conformity during IMRT planning

Some treatment planning systems optimize dose over objective functions via quasi-Newton or conjugate gradient search algorithms (1). Our in-house treatment planning system utilizes index-dose algorithm (2). Since different dose optimizer generate different plans, we are studying the potential benefit of combining different optimization methods in a single treatment planning system.

We have integrated the quasi-Newton gradient search into our in-house treatment planning system. The first plan was optimized using only index-dose to generate beam shapes and weights. Further optimization was performed by alternating quasi-Newton and index-dose until no further improvement was seen, resulting in the second plan. Those plans, in the figures below, were then combined with boost plans to make up composite plans.

Fig 1 and 2 show the DVH comparisons between plans optimized by index-dose only and those using the hybrid approach. For the prostate, the dose coverage at the prostate and bladder was close; while a better sparing for the rectum is achieved: $V_{50\%}$, $V_{60\%}$, and $V_{70\%}$ were reduced by 6%, 4% and 3%, respectively; the maximum rectal dose for 10 cc was reduced by 2%. The same target converge was found for the head and neck. The mean doses for the cord, larynx and left parotid were reduced by 6%, 5%, and 2%, respectively. $V_{70\%}$ for the cord was dropped by 25%, $V_{80\%}$ for the larynx was reduced by 14%, and $V_{40\%}$ for the parotid decreased by 5%. In both cases, total monitor units utilizing the hybrid optimizer were increased by less than one percent.

The hybrid optimizer proves to improve normal tissue sparing without sacrificing tumor target coverage for IMRT treatment, which could also be applied to ARC radiotherapy. This work also paves grounds for future study where multiple optimizers would effectively be integrated in one system to achieve better plan quality.

Reference: