Purpose: Intensity modulated proton therapy (IMPT) has the potential to deliver highly conformal dose distributions to target volumes via the superposition of a large number of independently weighted proton pencil beam spots. While smaller proton spots offer superior dose conformity, the increase in treatment time can be significant. The purpose of this study is to develop treatment planning strategies for IMPT that employ proton spots of different sizes, and evaluate the potential reduction in total number of spots and/or improvement in dose conformity given the same treatment time.
Methods: Two patient cases (prostate and lung) were analyzed by comparing three spot scanning strategies. Plans A and B use uniform spot sizes (standard deviation of the Gaussian profile) of 3mm and 6mm, respectively. Plan C uses a combination of 3mm and 9mm spots, placed close to the target surface and in the target center, respectively. Slight overlap between the two spot grids was allowed to provide adequate target coverage. The spot spacing was chosen to ensure uniform dose coverage to the target. Treatment plans were created to minimize dose to all normal structures while maintaining similar dose uniformity within the target.
Results: Target uniformity was similar for all planning techniques. Plan C achieved nearly the same conformity as plan A, but resulted in spot reductions of 58% and 71% for the prostate and lung cases respectively. Plan B required about the same number of spots as Plan A; however, the D20% to normal tissues near the target increased by 59.6% and 25.6% for the two cases compared with plan C.
Conclusions: Combining proton spots of various sizes in IMPT treatment planning allows for the same plan quality as with only using smaller spots. Depending on the target volume, up to a 70% reduction of number of spots can be achieved.