Purpose: To investigate a beam geometry selection algorithm based on sequential addition of beams.

Methods: The sequential beam addition algorithm (SBA) requires an objective function (score) and a set of candidate beam geometries (pool). The optimal score is determined for each beam in the pool and the best beam selected. Scores are then calculated for the selected beam in combination with each member of the pool. The pair with the best score is selected and the score again determined in combination with each beam in the pool. The process is repeated until the desired number of beams is reached. We selected 3 treatment sites, breast, lung, and brain, and determined beam arrangements for up to 11 beams from a pool comprised of 25 equi-angular transverse beams. For the brain, arrangements were additionally selected from a pool of 22 non-coplanar beams. Scores were determined for geometries comprised of equi-angular transverse beams (EQA), as well as two tangential beams for the breast case.

Results: In all cases, SBA resulted in scores superior to EQA. The breast case had the strongest dependence on beam geometry, for which only 7 beam EQA had a score better than the tangential beams, whereas all SBA geometries with more than two beams were superior. For the lung case, for both EQA and SBA the scores monotonically improved with increasing number of beams; however, SBA required fewer beams to achieve scores equivalent to EQA. For the brain case, SBA with a coplanar pool was equivalent to EQA, while the non-coplanar pool resulted in slightly better scores; however, the dose-volume histograms demonstrated that the differences were not clinically significant.

Conclusions: For situations in which beam geometry has a significant effect on the objective function, SBA can identify arrangements equivalent to equi-angular geometries but using fewer beams.

Funding Support, Disclosures, and Conflict of Interest:

Varian Medical Systems