Using OVH and IMRT plan data to automate VMAT planning: a head-and-neck study

**Background:** Although VMAT is widely used, VMAT planning faces challenges similar to those of IMRT planning, particularly with respect to planning efficiency and plan quality. Because the clinical achievable DVH objectives and weights (optimization parameters used in planning) that balance the conflicting needs of target coverage and sparing of OAR are not known *a priori* and dependent on patient geometry, VMAT planning, like IMRT, often requires many rounds of optimization, where planners repeatedly adjust optimization parameters in each optimization round to arrive at what personal experience and clinical feedbacks suggest is a clinically acceptable plan.

Several investigators have reported a strong dependence of IMRT plan quality on the experience of planners and the time that planners spend on planning. Although no published literature has discussed VMAT plan quality versus experience and time, VMAT plan quality is expected to have the same dependence considering the similarity of the two planning approaches. Therefore, VMAT planning, like IMRT, would benefit from a mechanism that improves efficiency as well as quality.

**Approach:** We previously introduced a geometry-driven, automated planning approach for IMRT by which planners use the dosimetric and geometric data of prior clinical IMRT plans to generate new plans. This approach uses a shape relationship descriptor, the overlap volume histogram (OVH), to search the database and identify a group of prior patients whose anatomy is relevant to that of new patients. The lowest (most favorable) OAR’s DVH points are retrieved from this reference group and used as the optimization parameters for new plans.

This approach has been shown to be an effective planning tool that improves the efficiency and quality of IMRT planning. Since VMAT planning encounters similar efficiency and quality issues that our approach has successfully addressed in IMRT planning, we have started to investigate the feasibility of adapting this approach to VMAT planning.

Our investigation focuses on head-and-neck (H&N) VMAT planning in the Pinnacle³ SmartArc TPS on an Elekta Infinity linac. Due to the lack of sufficient prior H&N clinical VMAT plans, we investigate whether prior H&N clinical IMRT plans can be used to guide and automate VMAT planning in light of the similarity between VMAT and IMRT planning and the comparability of the H&N dosimetric results. The goal of the study is to assess whether the automated planning approach using IMRT plan data can generate VMAT plans in shorter time with equal or better quality relative to clinical IMRT plans manually generated by dosimetrists.

In this study, 4 oropharynx, 4 nasopharynx and 4 larynx patients are randomly selected from a database containing clinical IMRT plan data of 182 previously treated patients. For each patient, an IMRT-data-driven VMAT plan is fully automated generated by the proposed approach. Then, the dosimetric results of the VMAT plans are compared with the corresponding clinical IMRT plans manually created by dosimetrists. The number of optimization rounds for a complete plan is used to evaluate planning efficiency between the two sets of plans.

**Results:** All IMRT-data-driven VMAT plans are automatically generated in two optimization rounds within 70 minutes, while the average optimization rounds in clinical IMRT oropharynx, larynx and nasopharynx planning are 28, 36 and 67. In VMAT plans, significant dose reductions ($p<0.05$) to the cord+4mm ($D_{0.1cc}$: 3.7 Gy), brainstem ($D_{0.1cc}$: 4.9 Gy), brachial plexus ($D_{0.1cc}$: 1.6 Gy), larynx ($V(50 \text{ Gy})$: 5.3%) and inner ear (mean dose: 4.4 Gy) with a slight degradation in low-level PTV coverage ($V_{95}$: 0.3%; $p=0.25$) are observed.

**Conclusion:** IMRT-data-driven VMAT planning is an efficient and effective way to automate VMAT planning.