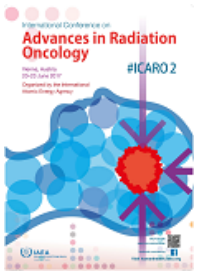

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Standardisation of treatment planning in frameless stereotactic radiosurgery and radiotherapy using volumetric modulated arc therapy (VMAT) beams

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Aim: To standardise stereotactic treatment planning for new cases through compiling and categorization of a large number of treatment plans for a variety of clinical scenarios and automating plan selection from this plan library based on patient specific parameters.

Materials and methods: One hundred and seventeen patients who were treated by stereotactic radiosurgery (SRS) or stereotactic radiotherapy (SRT) in our clinic for their intracranial lesions between March 2013 and December 2015 were included in this study. In all, 120 VMAT-based stereotactic plans (SRS/SRT) were generated for these patients and were pooled together to create a library of plans. All the plans were done in MONACO (v 5.00.04) treatment planning system (TPS) using the Monte Carlo dose calculation engine. These plans were categorized on the basis of eight different parameters: (i) Number of PTVs (ii) Prescription dose (iii) laterality (left /right) (iv) tumour volume (v) Whether PTV dose coverage was challenged by presence of organ at risk (OAR) or not, (vi) shortest distance between OAR and PTV (vii) centre to centre distance between OARs and PTV and (viii) lateral dimension of external contour (brain).

Subsequently, for every new patient, the most appropriate plan was chosen from this library of plans on the basis of above categorisation using an ensemble mapping auto-select technique. The programming was done with a macro-enabled Excel worksheet. The auto-selected treatment plan (ATP) from the library of plans was 'copied'to the new patient keeping all beam and optimization parameters unchanged and placing the isocenter at the center of the new patient's PTV. Optimization and dose calculation was carried out in the MONACO TPS with no or very minimal changes in the optimization constraints and arc lengths. In addition to this ATP, another individualized treatment plan (ITP) was generated by an experienced medical physicist independently without taking into consideration the library plan. The two sets of plans were compared. The ATP and the IP were evaluated for PTV receiving 98% prescription dose (V98%), Paddick conformity index (PCI) , dose spillage in terms of volumes receiving 50% and 20% of prescription dose (V50%, V20%) and OAR doses.

Results: For 43.3% (52 out of 120) patients it was observed that dose coverage to PTV was not challenged by the presence of any OAR. Validation results for ensemble mapping technique showed that the Excel program could select an appropriate plan from the plan library for the new patient in question.

Although the program could select the appropriate plan and ATP could be generated for the new patients, the independent plans were marginally better than the auto-select plans in PTV coverage and dose conformity. The mean PTV volume receiving 98% prescription dose (V98%) was 98.7±1.1% and 97.5±1.3% for the IP and auto-select plans respectively. Similarly the mean value for PTV's conformity index was slightly better in ITP (0.712) as compared to that for auto-selected plans (0.693). However both PTV V98% and PCI were not statistically different between two sets.

For the largest prescription dose group (12 Gy in 1#, 64 patients) brainstem 0.5 cc volume exhibited mean doses of 873.1±134.2 cGy and 854.5±122.4 cGy for ITP and ATP respectively. Mean 0.2 cc optic chiasm dose were 690.1±78.3 cGy and 734.0±67.8 cGy for ITP and ATP respectively. MU difference was very nominal with ITP showing a mean excess MU of 67.3 (3.7%) over ATP. ITP required on average 3.5 optimizations/dose calculation which ranged from 3.5 to 5 hrs, where as ATP required not more than 1.5 to 2 hrs.

Conclusion: ATP validation results indicated multidimensional ensemble mapping mechanism can pick up the appropriate plan from the library of plans accurately for new cases. ATP plans, even though marginally

inferior in plan quality to the ITP, can fulfil all the required clinical conditions and dose constraints. ATP plans save considerable planning time and is not dependent on the treatment planner's skills and expertise.

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