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Volume reduction in the CTV of glioblastoma from editing to intracranial anatomical boundaries

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Purpose/Objective: In patients with glioblastoma (GBM), microscopic tumour spread can extend a substantial distance away from the gross tumour volume (GTV), requiring large clinical target volume (CTV) margins. Tumour spread is limited by the skull and potentially by other intracranial structures. We examined the volume of the CTV which could be avoided by editing the CTV according to these barriers.

Materials and Methods: We used a dataset of 14 patients with GBM, each of which had been contoured 3 times, separated by at least a month, by 4 experienced Neuro-Oncologists. The imaging data sets consisted of a co-registered planning CT and contrast-enhanced T1 MRI. The majority of the patients had undergone debulking surgery (11); the other 3 had biopsy only. The use of multiple contours provided allowance for individual variation in contouring. The GTV was grown isotropically by 2.5 cm to generate the (pre-edit) CTV, which was automatically limited at the skull. Then, using a standardised department protocol, one oncologist edited the CTVs according to additional anatomical boundaries formed by the tentorium cerebelli and the falx. Key routes of spread were respected, including the cerebral peduncle for extension into the brain stem, the corpus callosum, and anterior and posterior commissures for trans-midline spread. The potential for spread through the inter-thalamic connection is uncertain, so this was also included as a potential route. The posterior fossa was excluded anatomically. Similar considerations could be applied to other high grade or low grade tumours.

Results: The pre-edit CTV was reduced in all cases, but the extent depended on the anatomical location. The biggest reductions achieved by anatomical editing of the CTV were seen in inferiorly located tumours, where isotropic growth had unnecessarily included part of the posterior fossa. It proved difficult to achieve major reductions in superiorly located tumours because of the proximity of the corpus callosum, with associated potential routes of spread. For central deep-seated or superiorly located tumours, the percentage reduction in CTV was 3 - 5%. For more inferiorly placed tumours, the reduction was 9 - 23%, depending on how low and close to the posterior fossa the GTV was located.

Conclusions: Editing of CTV according to internal anatomical barriers formed by the tentorium and falx is worthwhile, in reducing the volume of normal tissue which is treated unnecessarily. This is especially useful for tumours where isotropic CTV growth includes the posterior fossa. Newer Advancing imaging techniques to identify likely directions and extent of spread for individual patients would enhance this.

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Hypofractionated whole brain irradiation with hippocampal sparing and SIB for metastases: a dosimetric VMAT study

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Purpose/Objective: To develop a new volumetric modulated arc therapy (VMAT) treatment strategy to deliver hypofractionated whole brain radiotherapy (HWBRT) associated with a simultaneous integrated boost (SIB) in patient with one or more brain metastases. The aim of the study is to evaluate the dosimetric feasibility of HWBRT plus SIB adding a hippocampal sparing.

Materials and Methods: HWBRT prescription was 20 Gy in 5 fractions and SIB dose on brain metastases was 40 Gy in 5 fractions. The hippocampus anatomic definition and dosimetric constraints followed RTOG 0933 study. A planning organ at risk volume (PRV) of 5 mm margin was added isotropically to the hippocampal structures to allow a dose gradient with planning target volume (PTV_{WB}). PTV_{WB} was generated from the whole brain minus metastases PTVs (PTV_{SIB}) and PRV hippocampus. All plans were evaluated in terms of target coverage, homogeneity index, mean and maximum doses to the hippocampus. Planning objectives were as follows: PTV_{WB} $D_{2\%} \leq$ 25 Gy with an acceptable deviation of 26.7 Gy, $D_{98\%} \geq$ 16.7 Gy with an acceptable deviation <16.7 Gy, PTV_{SIB} $D_{95\%} \geq$ 38 Gy, hippocampus $D_{100} \leq$ 6 Gy with an acceptable deviation 6.7 Gy and D_{max} 10.7 Gy with an acceptable deviation 11.3 Gy and mean hippocampus dose of 8 Gy.

Results: Ten patients with diagnosis of brain metastases were analysed. The mean number of brain metastasis was 2 (range 1-5). Mean values for brain metastases were as follows: volume of PTV_{SIB}= 5.5±5.9 cc (range 0.7-19.4 cc), dose to 95% of PTV_{SIB} volume 39.9±0.3 Gy and homogeneity index 0.4±0.2 (range 0.3-0.6). The mean dose to the 90% of PTV_{WB} was 19.8±0.2 Gy and the mean homogeneity index was 0.08±0.02 (range 0.05-0.1). Mean hippocampal volume was 1.9±0.5 cc. Mean and maximum hippocampus doses were 7.7±0.2Gy (range 7.4-8 Gy) and 10.5±0.7Gy (range 9.4-11.3 Gy). Mean dose to 100% of the hippocampus volume ($D_{100\%}$) was 6.6±0.2 Gy (range 6.3-6.7).

Conclusions: HWBRT plus SIB with hippocampal avoidance by mean of VMAT was feasible. All dosimetric parameters considered as planning objectives were satisfied in terms of target coverage and homogeneity index for PTV_{WBRT} and PTV_{SIB}. A phase II clinical trial is necessary to establish the clinical benefit of hippocampal sparing in patients with brain metastasis and treated with hypofractionated regime.

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Feasibility of local deep hyperthermia treatment in conjunction with standard cancer treatments

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