

Reduction in total radiation exposure using X-ray image guidance illustrated in a patient receiving pituitary radiotherapy

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Dear Editor,

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2 Choudhury et al [1] discuss the considerable promise of MR-based image guidance, and we
3 strongly support the implementation and evaluation of this exciting technology. However,
4 for the foreseeable future most patients will be treated using X-ray-based image guidance
5 (IGRT). Although the importance of IGRT is well recognised [2], there is evidence that full
6 use of IGRT capability has not yet been achieved [2, 3], partly because of fear of the
7 radiation dose.
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11 IGRT is used primarily to ensure accurate dose delivery to the target. Once data on target
12 positioning data has been obtained, it is sometimes possible to reduce planning target volume
13 (PTV) margins. The figure shows the case of a patient with recurrent non-functioning
14 pituitary adenoma. His original plan was compared to an equivalent plan with reduced PTV
15 margin (5mm, volume 34.6 cm³, to 3mm, volume 24.7 cm³), as would be used now [4]. The
16 dose from daily cone beam CT (CBCT) image guidance scans was added to the 3mm plan
17 [5]. The dose difference map was produced by subtraction and clearly shows bands of
18 unnecessary dose.
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23 X-ray IGRT carries a ‘cost’ of radiation exposure. However, reduction of the PTV margin
24 *reduces* the overall radiation burden, as eloquently described by van Herk a decade ago [6].
25 Here, the 5 mm PTV plan with no IGRT would deliver an estimated absorbed energy of
26 24.97 J. The use of a 3 mm margin, combined with CBCT dose, delivers 21.59 J (difference
27 3.38 J or 13.5%). The additional energy from CBCT was estimated at 0.42 J (1.9 % of the
28 total). Use of IGRT with a lower frequency, permitting some PTV margin reduction, still
29 leads to reduced total patient dose.
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34 Thus, the use of X-ray IGRT can lead to a *reduction* in total radiation burden, which should
35 actively encourage its use.
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Figure

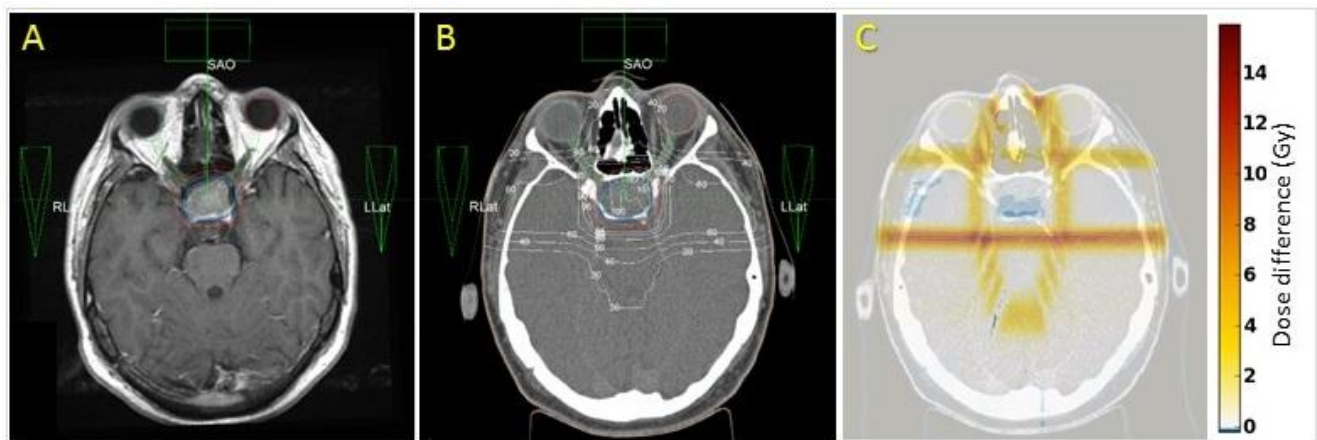


Figure. Planning MRI (A) and CT (B) scans with associated beams for a patient with recurrent pituitary adenoma. The GTV is shown in light blue, the CTV in dark blue. Two PTVs are shown: the inner (pink) has a 3mm CTV to PTV margin; the outer (red) has a 5mm margin. A conventional 6 MV conformal 3 field beam arrangement has been used, with a 5 mm multi-leaf collimator. Isodoses for the 5mm PTV plan are shown (B). (C) shows the dose difference map, comparing the 5 mm PTV plan with no image guidance to a 3 mm PTV plan with daily image guidance, to which the *daily image guidance dose has been added* (i.e. $\text{Difference} = [\text{Treatment dose 5mm margin}] - [\text{Treatment dose 3mm margin} + \text{CBCT dose}]$). The bands of dose difference, particularly lying posterior to the target, represent unnecessary treatment dose to which the patient would be subjected if IGRT and margin reduction are not used.