Treating patients with brain metastases has evolved: scalp-sparing, hippocampal avoidance whole brain radiotherapy with simultaneous integrated boost

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DESCRIPTION
A 43-year-old male with a history of receiving treatment for squamous cell carcinoma (SqCC) of lung 2 years back presented with a complaint of a single episode of self-resolving generalised tonic-clonic seizure 1 day prior. General physical and neurological examinations were unremarkable. An MRI of the brain revealed a well-defined, enhancing, space-occupying lesion (SOL) in the right temporal lobe (figure 1). He was started on oral dexamethasone, oral phenytoin (after an intravenous loading dose) and underwent a whole body ¹⁸fluorodeoxyglucose positron emission tomography CT (¹⁸FDG PET-CT), which revealed increased FDG uptake in the SOL without evidence of metastatic disease elsewhere (figure 1). A diagnosis of oligometastatic SqCC lung (cTx, cNx and cM1b) was made, and the options for management were discussed with the patient.

He refused surgery (based on risk for postsurgical neurological deficit) and stereotactic radiosurgery (based on anticipated need for future retreatment for intracranial disease recurrence, the costs of which were unacceptable to him). The risk of neurocognitive decline and permanent alopecia with whole brain radiotherapy (WBRT) was also unacceptable. We planned and treated the patient with scalp-sparing, hippocampal avoidance WBRT (30 Gray in 10 fractions, 2 weeks) with simultaneous integrated boost (45 Gray in 10 fractions, 2 weeks) delivered by image-guided volumetric modulated arc therapy (figure 2). Treatment planning and delivery were performed on Varian Eclipse V.13.5 and Varian TrueBeam V.2.5, respectively (Varian Medical Systems, Palo Alto, California, USA). Daily image guidance was performed with pretreatment cone beam CT (CBCT) verification, intratreatment kV planar verification and post-treatment CBCT.

The patient developed transient alopecia 2 weeks post-treatment with full recovery at 2 month follow-up (figure 3), and neurocognitive function (assessed by Hopkins Verbal Learning Tool-Revised) also remained stable on follow-up compared with pretreatment levels. One year hence, the patient has achieved near-complete response intracranially and remains progression free elsewhere, without any systemic therapy (figure 3).

The standard management of a patient with solitary brain metastasis is either upfront surgery, stereotactic radiosurgery (SRS), WBRT or a combination of these modalities. While surgery is considered the standard of care, the rate of in-hospital mortality is 2.3%, and 17% are discharged to long-term care facilities or rehabilitation centres. In recent years, there is an increased recognition of the deleterious effects of WBRT on neurocognitive outcomes, especially memory, which is not represented in the Mini-Mental Status Examination score. The key determinant of memory dysfunction after radiotherapy to the brain is the dose received by the hippocampus, a reservoir of neural stem cells responsible for the formation of new memories. SRS is considered a viable alternative to surgery with excellent local control and has better neurocognitive outcomes compared with WBRT, at the cost of higher rate of intracranial disease progression, which requires retreatment, usually with SRS. Results from a recent trial suggest that sparing the hippocampus preserves neurocognitive function and quality of life in patients undergoing radiotherapy for brain metastases. Another trial recently demonstrated that WBRT
Sparing the scalp and hippocampus is possible using modern radiotherapy techniques, without compromising therapeutic efficacy.

Incorporating a simultaneous boost to large volume intracranial metastases induces long-term durable response.

Sparing the scalp and hippocampus can counteract the issues of alopecia and memory dysfunction associated with whole brain radiotherapy.

Figure 3  Post-treatment MRI and patient images. (A,B) T1-weighted contrast enhanced axial and sagittal images reveal near complete response in the lesion (red arrows). (C) Pretreatment patient image demonstrating scalp hair distribution. (D) Post-treatment patient image taken 2 weeks after completion of treatment demonstrating alopecia totalis. (E) Post-treatment patient image taken 2 months after completion of treatment demonstrating return of normal scalp hair distribution.

Learning points

- Sparing the scalp and hippocampus is possible using modern radiotherapy techniques, without compromising therapeutic efficacy.
- Incorporating a simultaneous boost to large volume intracranial metastases induces long-term durable response.
- Sparing the scalp and hippocampus can counteract the issues of alopecia and memory dysfunction associated with whole brain radiotherapy.

Contributors  IA is the treating junior consultant (radiotherapy), author of the paper, responsible for drafting the manuscript and revising it. He is the guarantor. KSC is the supervising treating consultant (radiotherapy) and participated in article formulation, editing and oversight. CPB is the medical physicist, responsible for generating the radiation treatment plan, performing quality assurance of delivered plan and also participated in article editing. SR is the radiation technologist, responsible for creating the treatment setup, ensuring reproducible setup and treatment delivery during the course of treatment. He also participated in article editing.

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REFERENCES


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