

Radiation-Induced Brain Injury in Meningioma Patients Treated with Proton or Photon Therapy

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Purpose:

Proton therapy is often utilized for patients with meningioma given its ability to achieve a lower integral brain dose. However, it is unclear whether rates of brain injury are different due to uncertainties in end of range effects. In the EORTC 22042-26042 study which evaluated 56 patients treated with adjuvant 60 Gy photons after resection of G2 meningioma, there was 14.3% grade ≥ 3 adverse events and a 1.8% grade 2 CNS necrosis. In RTOG 0539, which evaluated patients treated with adjuvant 54 Gy photons after resection of G2I meningioma, there were no grade ≥ 3 events and 23.5% grade 2 neurologic adverse events. The purpose of this study is to characterize and compare rates of brain injury after proton or photon therapy.

Materials/Methods:

- Radiation induced brain injuries were categorized into white matter lesions (WML) defined as newly detected abnormal T2 signal intensities, or radiation necrosis (RN) defined as newly detected abnormal T2 and T1 post contrast signal intensities.
- We retrospectively reviewed 38 consecutive patients treated with proton therapy from 2014-2017 and 39 patients treated with photon therapy from 2008-2018 from two separate academic institutions.
- Patients with previous radiation therapy or less than 3 months follow up were excluded.
- Patient, tumor and treatment characteristics are listed in (Table 1.), there was no significant difference between the two groups.
- In the proton group, 23 patients were treated with pencil beam scanning and 15 with uniform scanning. Thirty two patients were treated with 1-2 beams and six with 3-4 beams.
- Follow up imaging was reviewed by an experienced neuro-radiologist and radiation oncologist. Abnormal MRI scans were then reviewed after fusion with initial radiation plans.
- Toxicity was graded as per CTCAE v4.03.

Results:

- Median follow-up time was 17.5 months for proton and 24 months for photon therapy.
- The cumulative incidence of WML at 2 years was 34.2% (n=13) after proton and 48.7% (n=19) after photon therapy (p=0.20). Three patients had symptomatic WML (grade ≥ 2) after protons compared to two patients after photons.
- The cumulative incidence of RN at 2 years was 18.4% (n=7) after proton and 2.6% (n=1) after photon therapy (p=0.02).
- In the proton group, symptomatic RN (grade ≥ 2) was recorded in 3 patients and one patient had a grade 4/5 event, none of these events resolved after medical management. Three RN cases were treated with uniform scanning and four with pencil beam.
- In the photon group, symptomatic RN (grade ≥ 2) was recorded in 1 patient and it did not resolve.

Conclusion:

Patients treated with either proton and photon beam therapies have high rates of developing parenchymal T2 signal intensity abnormalities. However, in our series, patients were more likely to develop parenchymal T1 post-contrast abnormalities after proton therapy. Further study into strategies to decrease risk of brain injury may be warranted to optimize treatment for meningioma patients.

References:

Rogers et al J Neurosurg 2017, Weber DC et al Rad Oncol 2018

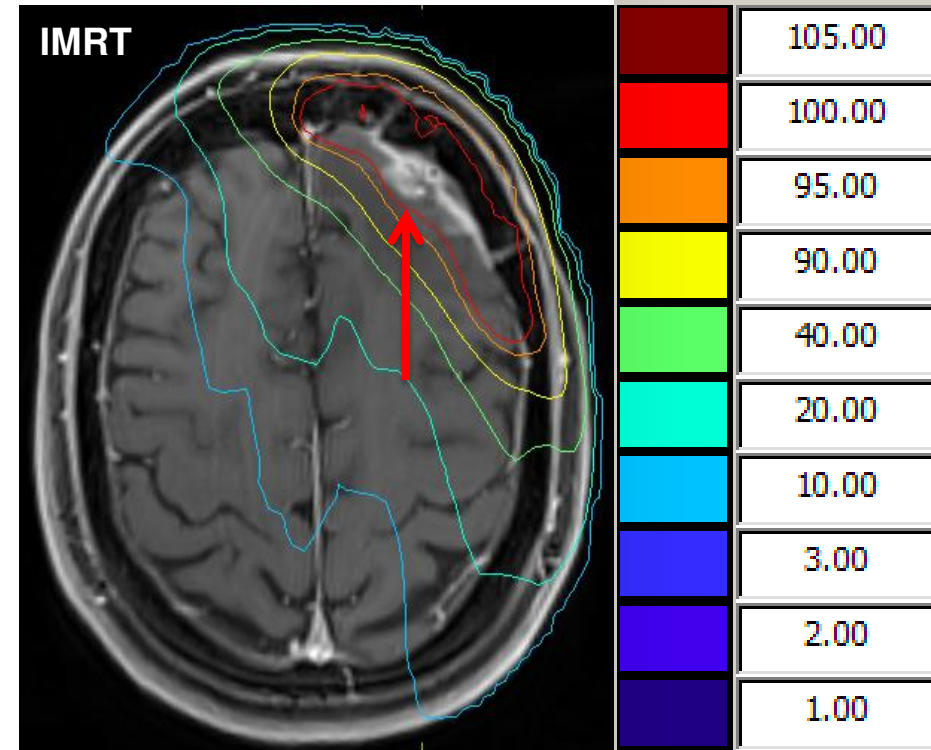
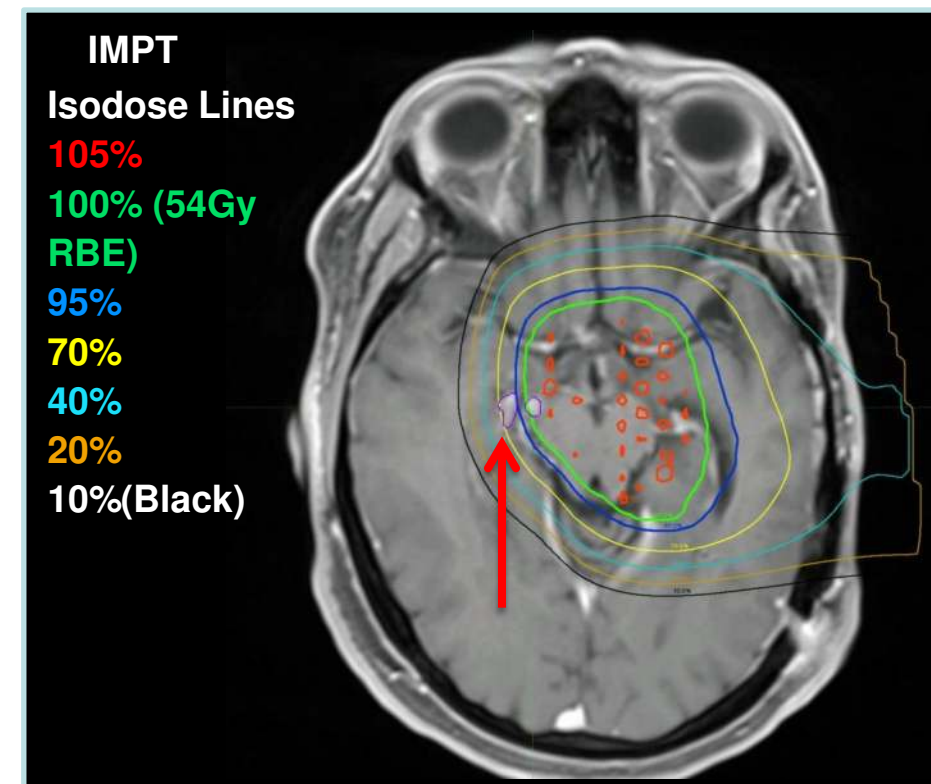
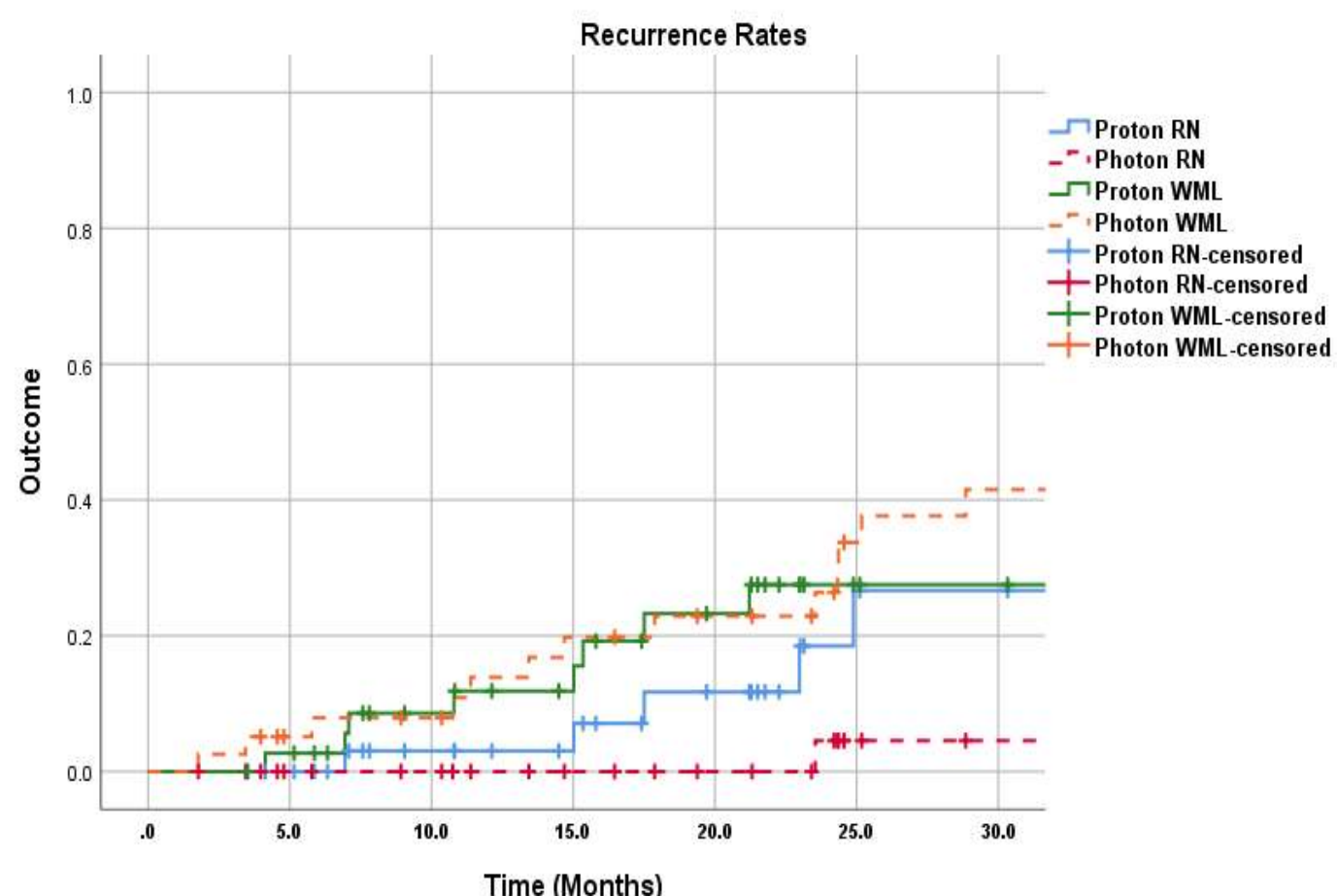


Figure 1. IMPT (Top) & IMRT (Bottom) Plans fused with the follow up MRI scans with RN

Table 1. Patient & Tumor characteristics		
Characteristic	Proton	Photon
Number of Patients (n)	38	39
Median Age (y)	55	58
Hx of Stroke	2	0
Hx of Diabetes	6	8
WHO G1	7	10
WHO G2	24	24
WHO G3	3	5
Median Tumor Diameter	3.7cm	3.7cm
Median CTV Volume	69cc	57cc
Pre-Surgical Embolization	16	1
Gross Total Resection	14	23
Sub-Total Resection	13	11
Median Dose (GCE or Gy)	54	54
Number of Fractions	30	27
Cyber-knife Boost	0	9



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