WHO Grades II and III Glioma

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Contents

14.1 General Principles of Simulation and Target Delineation (Table 14.1 and Fig. 14.1)

- CT simulation with a thermoplastic mask for immobilization.
- Obtain a volumetric thin slice MRI with T1 pre- and post-gadolinium, T2, and FLAIR for target delineation. The gross target volume (GTV) for low-grade glioma is the non-enhancing and enhancing mass which is best visualized on FLAIR sequences and T1 post-gadolinium sequences, respectively.

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Table 14.1 Suggested target volumes

Target volumes	Definition and description
GTV	Tumor extent and resection cavity on postoperative FLAIR and T1 post-gadolinium images. Preoperative MRIs can be helpful in determining residual disease from postoperative edema. For grade III gliomas, a cone down in a two-phase ($GTV_{conedown}$) technique can target the contrast-enhanced tumor.
CTV	GTV + 1.0–1.5 cm. This should be edited around anatomic boundaries such as the bone, tentorium, falx, and dura 1.0 cm for grade II and/or IDH mutant glioma; 1.0–1.5 cm for grade III and/or IDH wild-type glioma. If a cone down is planned after 50.4 Gy for grade III and/or IDH wild-type glioma, the $CTV_{conedown}$ will be $GTV_{conedown}$ + 1.0–1.5 cm.
PTV	CTV + 0.3–0.5 cm depending on comfort of patient positioning, mask fit, image guidance technique (AP/lateral imaging or cone beam CT), and if rotational corrections are being corrected with a 6-degree-of-freedom couch. By the same token, $PTV_{conedown}$ will be 0.3–0.5 cm expansion from $CTV_{conedown}$.

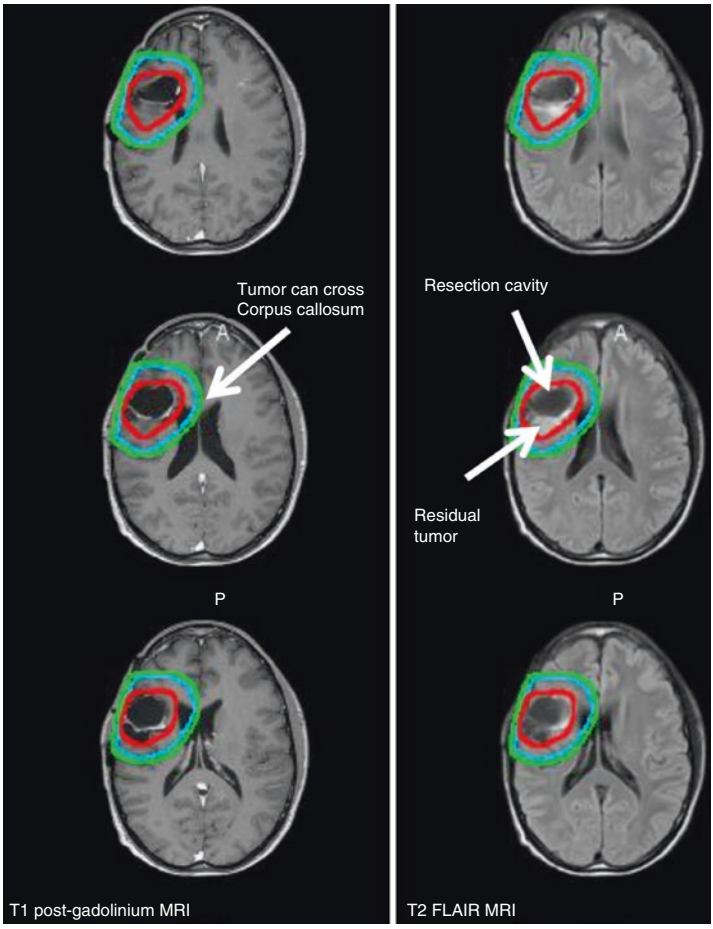

Fig. 14.1 Contours for a patient with WHO grade II oligodendroglioma, with IDH mutation and 1p19q codeletion, of the right frontal lobe. GTV, red; CTV, blue; PTV, green

- Ideally, fuse both the preoperative and postoperative T2/FLAIR and post-gadolinium MRIs to help delineate target volume; however, the postoperative MRI is what determines the volumes.
- If the patient has contraindications to MRI, can use CT with and without contrast, but this is substandard.
- In cases of partial or complete lobectomy, the region anterior to the resection edge where no brain tissue is present does not need to be included in the GTV.
- CTV expansion should respect natural anatomic barriers, including the bone, tentorium, fax, and dura.
- Tumors can cross the corpus callosum, which should be included in CTV expansion.
- 3D conformal, IMRT, or proton therapy can be considered to spare normal brain and hippocampi when possible.

14.2 Dose Prescriptions

- 50.4–60 Gy in 1.8–2.0 Gy fractions.
- Grade II and/or IDH mutant glioma: 50.4–54 Gy.
- Grade III and/or IDH wild-type glioma: 59.4–60 Gy; if there is no contrast enhancement, the PTV will be treated to the full dose; in some centers, if there is contrast enhancement, a cone down will occur after 50.4 Gy.

In the past, 50.4–54 Gy for grade II glioma and 59.4–60 Gy for grade III glioma. With the publication of the *2016 World Health Organization Classification of Tumors of the Central Nervous System*, gliomas are now classified by IDH mutation rather than grade given it has better prognostic value. Though controversy in this area exists, many consider dose dependent on IDH mutation status rather than grade.

14.3 Treatment Planning Techniques

- 3D CRT, IMRT, VMAT, or proton therapy may be used with the goal of sparing the contralateral brain, hippocampi, cochleae, and pituitary if possible (Figs. 14.2 and 14.3).
- Treatment planning aimed to cover 95% of the PTV volume by 95% of the prescribed dose for photon plans and 100% of the CTV volume by 100% of the prescribed dose for proton plans while respecting the OAR constraints. For complex tumors adjacent to critical OAR like the chiasm, brain stem, and optic nerves, coverage may suffer to 90% coverage of the PTV by 95% of the prescribed dose and plan acceptability taken on a case-by-case basis (Table 14.2).

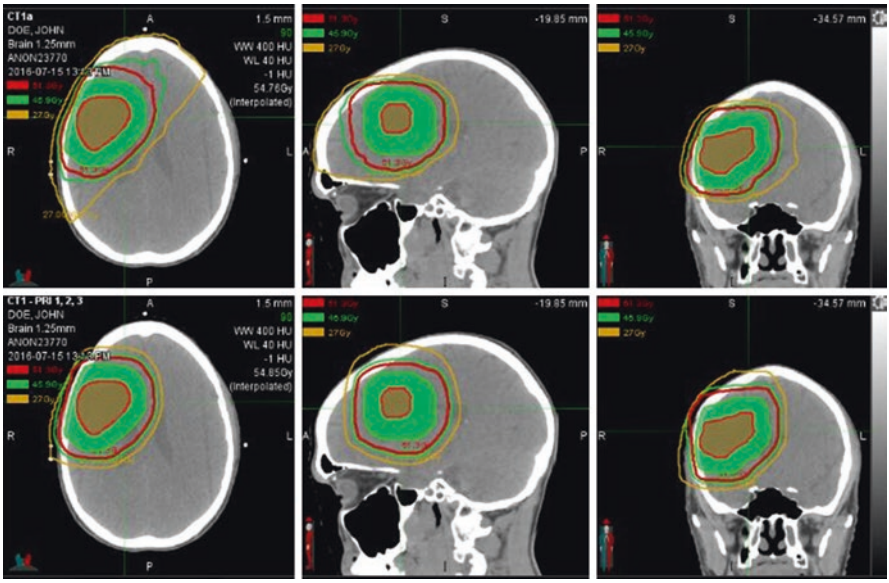

Fig. 14.2 Sample plan for the above patient with WHO grade II oligodendroglioma of the right frontal lobe. IMRT plan is on the top and a proton plan is on the bottom. Red line is 95% isodose line, green is 85% isodose line, and yellow is 50% isodose line

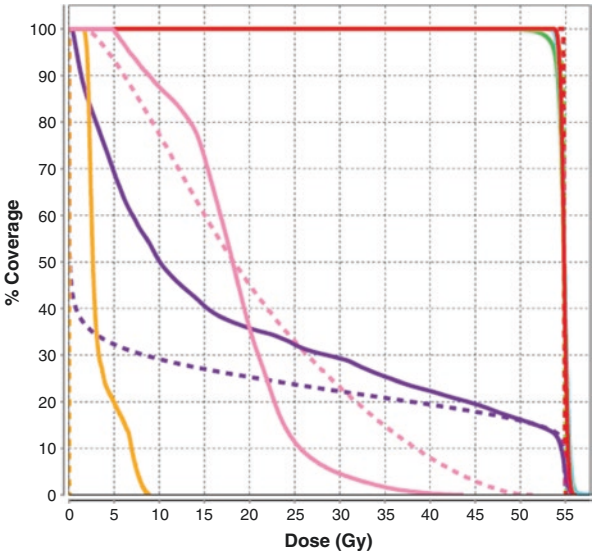

Fig. 14.3 Sample dose-volume histogram for the above patient with WHO grade II oligodendroglioma of the right frontal lobe. IMRT plan, solid line; proton plan, dotted line. GTV, red; CTV, blue; PTV, green; contralateral hippocampus, orange; ipsilateral hippocampus, pink; brain, purple

Table 14.2 Recommended normal tissue constraints for 1.8 Gy/day fractionation schemes

Organs at risk	Suggested dose constraints
Optic nerves and chiasm	<54 Gy [1]
Globe	<45 Gy [1]
Lenses	<10 Gy [1]
Lacrimal glands	<30 Gy, mean <25 Gy without compromising tumor coverage [2]
Brain stem	<54 Gy or <60 Gy, depending on prescription dose
Hippocampi	Beam angles and planning techniques (e.g., IMRT or proton therapy) to minimize dose to hippocampi
Pituitary gland	Beam angles and planning techniques (e.g., IMRT or proton therapy) to minimize dose to pituitary

Table 14.3 Side effects

Acute	Hair loss, fatigue, headaches, nausea, and cerebral edema causing neurological symptoms
Long-term	Neurocognitive decline and hypopituitarism. Radiation necroses 5%
Uncommon or rare risks	Pseudoprogression causing neurological symptoms, vision loss, hearing loss, secondary malignancies

14.4 Side Effects

See Table 14.3.

References

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Further Reading

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