Protocols Neuro-OncoRadiotherapy Adults v2.2

Date Approval: 23-02-2022

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1 Conventional Fractionation

Indication		Prescription	Imaging for delineation	Delineation	references
Glioma					
	Grade I	45-50.4Gy/1.8Gy	**BRAIN:** Preop: MRI T1 + Gado, (T2), FLAIR Postop: MRI T1 + Gado, T2, FLAIR	GTV: T1 enhancement	[1][2]
	Grade II, IDH mut	50.4-(54Gy)/1.8Gy		GTV: Resection Cavity* + (T2)/Flair positive CTV: GTV + 1cm PTV: CTV + 3mm	EORTC 22844 [3] EORTC 22845 [4,5] EORTC 22033/26033 [6] RTOG 9802 [7,8]
	Grade III, IDH mut	59.4Gy/1.8Gy		GTV: Resection cavity* + T1 contrast enhancement CTV: GTV + 1,5cm	RTOG 9813 [9] RTOG 9402 [10] EORTC 26951 [11] CODEL [12]

				(check if T2/FLAIR is inside CTV) PTV: CTV + 3mm GTV: Resection cavity* + T1 contrast enhancement CTV: GTV + 1.5cm (T2/FLAIR should not specifically included otherwise specified by the radiologist as potentially tumoral) PTV: CTV + 3mm	CATNON [13] NOA04 [14]
	Grade IV / any grade IDH wt	60Gy/2Gy			RT after surgery [15] RT in elderly [16] Stupp [17] NOA-08 [18]
		40.05/2.67 Preferred if age >= 70 and/or KPS < 70 Alternatives to BSC: 5x5 Gy or 10x3.4 Gy (without concomitant TMZ)			NCIC CTG CE.6 [19] ESTRO-EANO [20]
* In polar tumours, without dural contact where a gross total resection is achieved and hence no resection cavity remains, omission of the evacuated fossa or dural resection bed may be considered.					

References

[1] Brown PD, Buckner JC, O'Fallon JR, Iturria NL, Brown CA, O'Neill BP, et al. Adult patients with supratentorial pilocytic astrocytomas: a prospective multicenter clinical trial. Int J Radiat Oncol 2004;58:1153–60. doi:10.1016/j.ijrobp.2003.09.020.

[2] Theeler BJ, Ellezam B, Sadighi ZS, Mehta V, Tran MD, Adesina AM, et al. Adult pilocytic astrocytomas: clinical features and molecular analysis. Neuro Oncol 2014;16:841–7. doi:10.1093/neuonc/not246.

[3] Karim ABMF, Maat B, Hatlevoll R, Menten J, Rutten EHJM, Thomas DGT, et al. A randomized trial on dose-response in radiation therapy of low-grade cerebral glioma: European Organization for Research and Treatment of Cancer (EORTC) study 22844. Int J Radiat Oncol 1996;36:549–56. doi:10.1016/S0360-3016(96)00352-5.

[4] Karim ABM., Afra D, Cornu P, Bleehan N, Schraub S, De Witte O, et al. Randomized trial on the efficacy of radiotherapy for cerebral low-grade glioma in the adult: European Organization for Research and Treatment of Cancer Study 22845 with the Medical Research Council study BRO4: an interim analysis. Int J Radiat Oncol 2002;52:316–24. doi:10.1016/S0360-3016(01)02692-X.

[5] van den Bent M, Afra D, de Witte O, Hassel M Ben, Schraub S, Hoang-Xuan K, et al. Long-term efficacy of early versus delayed radiotherapy for low-grade astrocytoma and oligodendroglioma in adults: the EORTC 22845 randomised trial. Lancet 2005;366:985–90. doi:10.1016/S0140-6736(05)67070-5.

[6] Baumert BG, Hegi ME, van den Bent MJ, von Deimling A, Gorlia T, Hoang-Xuan K, et al. Temozolomide chemotherapy versus radiotherapy in high-risk low-grade glioma (EORTC 22033-26033): a randomised, open-label, phase 3 intergroup study. Lancet Oncol 2016;17:1521–32. doi:10.1016/S1470-2045(16)30313-8.

[7] Shaw EG, Berkey B, Coons SW, Bullard D, Brachman D, Buckner JC, et al. Recurrence following neurosurgeon-determined gross-total resection of adult supratentorial low-grade glioma: results of a prospective clinical trial. J Neurosurg 2008;109:835–41. doi:10.3171/JNS/2008/109/11/0835.

[8] Buckner JC, Shaw EG, Pugh SL, Chakravarti A, Gilbert MR, Barger GR, et al. Radiation plus Procarbazine, CCNU, and Vincristine in Low-Grade Glioma. N Engl J Med 2016;374:1344–55. doi:10.1056/NEJMoa1500925.

[9] Chang S, Zhang P, Cairncross JG, Gilbert MR, Bahary J-P, Dolinskas CA, et al. Phase III randomized study of radiation and temozolomide versus radiation and nitrosourea therapy for anaplastic astrocytoma: results of NRG Oncology RTOG 9813. Neuro Oncol 2016;19:now236. doi:10.1093/neuonc/now236.

[10] Cairncross G, Wang M, Shaw E, Jenkins R, Brachman D, Buckner J, et al. Phase III Trial of Chemoradiotherapy for Anaplastic Oligodendroglioma: Long-Term Results of RTOG 9402. J Clin Oncol 2013;31:337–43. doi:10.1200/JCO.2012.43.2674.

[11] van den Bent MJ, Brandes AA, Taphoorn MJB, Kros JM, Kouwenhoven MCM, Delattre J-Y, et al. Adjuvant Procarbazine, Lomustine, and Vincristine Chemotherapy in Newly Diagnosed Anaplastic Oligodendroglioma: Long-Term Follow-Up of EORTC Brain Tumor Group Study 26951. J Clin Oncol 2013;31:344–50. doi:10.1200/JCO.2012.43.2229.

[12] Jaeckle K, Vogelbaum M, Ballman K, Anderson S. CODEL (Alliance-N0577; EORTC-26081/22086; NRG-1071; NCIC-CEC-2): phase III randomized study of RT vs. RT+ TMZ vs. TMZ for newly diagnosed 1p/19q 2016.

[13] van den Bent MJ, Baumert B, Erridge SC, Vogelbaum MA, Nowak AK, Sanson M, et al. Interim results from the CATNON trial (EORTC study 26053-22054) of treatment with concurrent and adjuvant temozolomide for 1p/19q non-co-deleted anaplastic glioma: a phase 3, randomised, open-label intergroup study. Lancet 2017;390:1645–53. doi:10.1016/S0140-6736(17)31442-3.

[14] Wick W, Roth P, Hartmann C, Hau P, Nakamura M, Stockhammer F, et al. Long-term analysis of the NOA-04 randomized phase III trial of sequential radiochemotherapy of anaplastic glioma with PCV or temozolomide. Neuro Oncol 2016;18:now133. doi:10.1093/neuonc/now133.

[15] Walker MD, Strike TA, Sheline GE. An analysis of dose-effect relationship in the radiotherapy of malignant gliomas. Int J Radiat Oncol 1979;5:1725–31. doi:10.1016/0360-3016(79)90553-4.

[16] Keime-Guibert F, Chinot O, Taillandier L, Cartalat-Carel S, Frenay M, Kantor G, et al. Radiotherapy for Glioblastoma in the Elderly. N Engl J Med 2007;356:1527–35. doi:10.1056/NEJMoa065901.

[17] Stupp R, Mason WP, van den Bent MJ, Weller M, Fisher B, Taphoorn MJB, et al. Radiotherapy plus Concomitant and Adjuvant Temozolomide for Glioblastoma. N Engl J Med 2005;352:987–96. doi:10.1056/NEJMoa043330.

[18] Wick W, Platten M, Meisner C, Felsberg J, Tabatabai G, Simon M, et al. Temozolomide chemotherapy alone versus radiotherapy alone for malignant astrocytoma in the elderly: the NOA-08 randomised, phase 3 trial. Lancet Oncol 2012;13:707–15. doi:10.1016/S1470-2045(12)70164-X.

[19] Perry JR, Laperriere N, O'Callaghan CJ, Brandes AA, Menten J, Phillips C, et al. Short-Course Radiation plus Temozolomide in Elderly Patients with Glioblastoma. N Engl J Med 2017. doi:10.1056/NEJMoa1611977.

[20] Niyazi M, Andratschke N, Bendszus M, Chalmers AJ, et al. ESTRO-EANO guideline on target delineation and radiotherapy details for glioblastoma. Radiother Oncol. 2023 Jul;184:109663. doi: 10.1016/j.radonc.2023.109663.

Meningioma					
	Grade I	50.4-54Gy/1.8-2.0 Gy	**BRAIN:** Preop: MRI T1 + Gado, T2, FLAIR Postop: MRI T1 + Gado, T2, FLAIR CT scan for bone extension Consider PET-choline or dotatate for complex cases / doubtful delineation	GTV: T1 contrast enhancement. – Cavé: - Dural tail!(MRI→if distinction with tumor is clear, do not include) - Bone invasion (on CT, correlated to T1Gd+) - PET-choline or dotatate for complex cases / doubtful extension CTV: GTV PTV: GTV + 1mm (if stereotacitic mask) of 3mm (conventional mask) + daily IGRT	Complex cases to be discussed with neuro-radiologist
	Grade II-III	60Gy/2Gy		GTV: resection cavity + T1 contraste enhancement. – Cavé: - Dural tail! - Bone invastion (CT) - Brain invasion CTV: GTV + 5mm in the brain, 1cm along the dura PTV: CTV + 3mm (with daily IGRT)	
Craniopharyngeoma					
		54 Gy/1.8Gy	**BRAIN:**	GTV: Cyst + Contrast enhancement	

			Preop: MRI T1 + Gado, T2, FLAIR Postop: MRI T1 + Gado, T2, FLAIR	CTV: GTV + 3mm PTV: CTV + 1 (stereo) or 3 (common) mm+ with daily IGRT Replanning cystic lesion every two weeks	
Germinoma			**BRAIN** Preop: MRI T1 + Gado, T2, FLAIR Postop: MRI T1 + Gado, T2, FLAIR **SPINE** MRI T1+Gado, T2, FLAIR		
	Localized	Whole ventricular: 24Gy Boost 16Gy Local treatment only in case of chemotherapy		CTV: whole ventricles + 5mm PTV: CTV + 3mm	
	Metastatic	CSI 24 Gy Boost 16 Gy		GTV: tumor CTV: GTV + 5mm PTV: CTV + 3mm	
				CSI: cfr SIOPE guidelines	
	NGGCT	RT identical both for standard and high risk			
		Localized	Local treatment 54Gy 1.8Gy	GTV: resection cavity + residual disease CTV: 5-10mm PTV: 3mm	
		Metastatic	CSI 30Gy Boost up to 54Gy	Boost: cfr localized CSI: cfr SIOPE guidelines	
Pituitary Adenoma					

	Secreting	50.4- 54Gy/1.8Gy	**BRAIN:** Preop: MRI T1 /- Gado, T2, FLAIR Postop: MRI T1 +/- Gado, T2, FLAIR Dedicated pituitary imaging is advised (coronal, centered)	GTV: residual tumor PTV: GTV +1-3mm (fct of immobilisation)	
	Non-Secreting	45/1.8Gy		GTV: residual tumor PTV: GTV + 1-3mm (fct of immobilisation)	
Medulloblastoma					
	Standard Risk	CSI: 36Gy/1.8 Gy Boost: 18 Gy/1.8 Gy	**BRAIN** Preop: MRI T1 + Gado, T2, FLAIR Postop: MRI T1 + Gado, T2, FLAIR **SPINE** MRI T1+Gado, T2, FLAIR	GTVp: resection cavity and residual macroscopic disease GTVm: Metastasis on MRI CTVp: GTV + 5mm CTVp_cranial CTVp_Spinal Cfr Guidelines SIOPE	
	High Risk	CSI: 36 Gy Boost: 18Gy/1.8Gy Spinal boost: 14.4 Gy/1.8Gy			
Ependymoma					
Grade I ependymoma		50.4-54Gy/1.8Gy	**BRAIN** Preop: MRI T1 + Gado, T2, FLAIR Postop: MRI T1 + Gado, T2, FLAIR **SPINE** MRI T1+Gado, T2, FLAIR	GTV: resection cavity + macroscopic tumor CTV: GTV + 5mm	
Grade II-III		59.4Gy/1.8Gy			
Spine MRI/CSF+		CSI: 36 Gy/1,8Gy		CTVp_cranial CTVp_Spinal	
Schwannoma					
		50.4Gy/1.8Gy	**BRAIN:** MRI T1 3D + Gado, T2, FLAIR CISS images	GTV: tumor PTV: GTV + 1mm (with stereotactic mask)	

Remarks:

- All curative CSI indications need to be referred to Particle for Protontherapy treatment (boost inclusive).

2 Hypofractionated Stereotactic Radiotherapy/Radiosurgery

Indication	Prescription	Imaging for delineation	Delineation	Planning
Metastasis	not covered here			
Vestibulair schwannoma	SRS: 1x 12Gy FSRT: 3x6 Gy every other day FSRT: 5x5Gy every other day	**BRAIN:** MRI T1 + Gado, T2, FLAIR CISS images	GTV: on MRI images FSRT: PTV= GTV +0.5-1 mm (with stereotactic mask, according to local setup)	
Meningioma	SRS: 1x14Gy FSRT: 5x5Gy every other day	**BRAIN:** MRI 3D T1 FatSat + Gado, T2, FLAIR CT (bone invasion) PET-choline or dotatate to be considered if needed (see upper)	GTV: tumor on MRI GTV = CTV PTV: 0.5 to 1mm (according to local setup)	
AVM	SRS: 1x18-24Gy FSRT: 5x7Gy 2x/week	**BRAIN:** MRI T1 + Gado, T2, FLAIR CISS images CT: AngioCT images XA: arteriography	GTV: nidus (+ radiology + NCH)	
Pituitary Adenoma	SRS: up to 1x20 Gy FSRT: 5x5 Gy every other day	**BRAIN:** Preop: MRI T1 /- Gado, T2, FLAIR Postop: MRI T1 +/- Gado, T2, FLAIR Dedicated pituitary imaging is advised (coronal, centered)	GTV=tumor rest PTV=GTV+0.5-1mm (according to local setup)	