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General Principles of Target Delineation

- The surgical approach (midfacial degloving, lateral rhinotomy, craniofacial, or endoscopic), can complicate the radiation field. If a craniofacial resection has been performed, the frontal graft should be included in the target volume. Fiducial markers implanted during surgery can help to delineate the tumor bed.
- Preoperative CT and MRI should be evaluated to ensure that the initial tumor volume is covered in the high-risk CTV. Detailed description of the surgical procedure and pathology report is mandatory to properly define the CTV that should encompass all initial sites of disease and the subclinical tumor spread. MRI should be used in all cases to help delineation of the tumor unless medically contraindicated.
- Adenoid cystic carcinomas are highly neurotrophic so radiotherapy volumes must encompass the afferent and efferent local nerves to the skull base. Esthesioneuroblastomas arise in the superior nasal cavity and in their early stages tend to invade the cribriform plate and anterior cranial fossa, and therefore, these regions should be encompassed in the target volume.
- Lymph node metastases are unusual, so elective treatment of the neck is not mandatory but can be done at the discretion of the treating physician. However, elective neck irradiation should be considered for esthesioneuroblastoma; high-grade, high-stage squamous cell carcinoma, especially if originating from the maxillary sinus or there is invasion of the mucosa of the palate or of the nasopharynx; when there is involvement of

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Table 6.1 Suggested target volumes for gross disease

Target volumes	Definition and description
GTV ₇₀	All gross disease on physical examination and imaging (CT and MRI). PET can help further define the tumor extent
CTV ₇₀	Usually same as GTV ₇₀ . If a margin is needed due to uncertainty during gross disease delineation, add 3–5 mm so that GTV ₇₀ + 3–5 mm = CTV ₇₀
PTV ₇₀	CTV ₇₀ + 3–5 mm depending on comfort level and can be as small as 1 mm when near critical normal structures

Table 6.2 Suggested target volumes at the high- and low-risk subclinical regions

Target volumes	Definition and description	
	Ethmoid	Maxillary
CTV ₆₆	Tumor implantation area or microscopically affected margins	
CTV ₆₀	<p>The CTV₆₀ should encompass the areas at high risk of microscopic tumor spread from initial macroscopic tumor. Although the CTV₆₀ has to be defined in a case-by-case evaluation, the general proposed limits are:</p> <p><i>Superior:</i> if the cribriform plate has not been resected, it should be included for ethmoid sinus tumors; if it has been resected, the CTV₆₀ should encompass the dura or the dural graft, extending at least 10 mm superior to the cribriform plate or encompass the initial gross tumor volume</p> <p><i>Inferior:</i> the inferior turbinate; if the inferior border of the tumor allows a 10-mm margin around the original disease, then the entire hard palate does not need to be included</p> <p><i>Lateral:</i> the nasal cavity, ethmoid sinuses, and the ipsilateral maxillary sinus and when indicated the volume should extend to the rectus muscle</p> <p><i>Posterior:</i> include the sphenoid sinus. The retropharyngeal lymph nodes should be encompassed if the tumor extended close to the nasopharynx or if there are metastatic neck nodes from an ethmoidal carcinoma</p>	
		<p><i>Inferior:</i> the inferior border of the maxilla and the hard palate but should encompass a 10-mm margin around the initial gross disease</p> <p><i>Lateral:</i> medial aspect should be the nasal septum, unless violation of midline structures occurs</p> <p><i>Posterior:</i> the pterygopalatine and the infratemporal fossa should be included, paying special attention to encompass the masticator space and the infraorbital fissure</p>
PTV _{66*}	CTV ₆₆ + 3–5 mm, depending on comfort level of daily patient positioning. Image guidance is recommended to reduce random and systematic setup errors. The PTV can be further modified to produce expansions as small as 1 mm in areas adjacent to critical normal structures	
PTV _{60*}	CTV ₆₀ + 3–5 mm, depending on comfort level of patient positioning but can be as small as 1 mm in areas adjacent to critical normal tissues	

*High-risk subclinical dose: postoperatively 2 Gy/fraction to 60 Gy or 66 Gy (any region that has been surgically violated should be kept at least to 2 Gy per fraction); for the nonsurgically violated neck or prophylactic cranial nerves coverage, consider 1.8 Gy/fraction to 54 Gy (PTV₅₄). In the radical setting when a simultaneous integrated boost is used with chemotherapy, the suggested doses are 1.8 Gy/fraction to 59.4 Gy, and 1.64 Gy/fraction to 54 Gy. PTV₇₀ can be treated either in 2 Gy or 2.12 Gy per fraction

the skin of the cheek or of the anterior nose; and invasion of the maxillary gingiva or the alveolus. Depending on the clinical situation (if tumor is well lateralized or if it crosses the midline), the lymph node levels Ib-IV can be covered (either unilaterally or bilaterally based on the clinical scenario).

- Suggested target volumes at the gross disease and high- and low-risk regions are detailed in Tables 6.1 and 6.2 (Figs. 6.1 and 6.2).

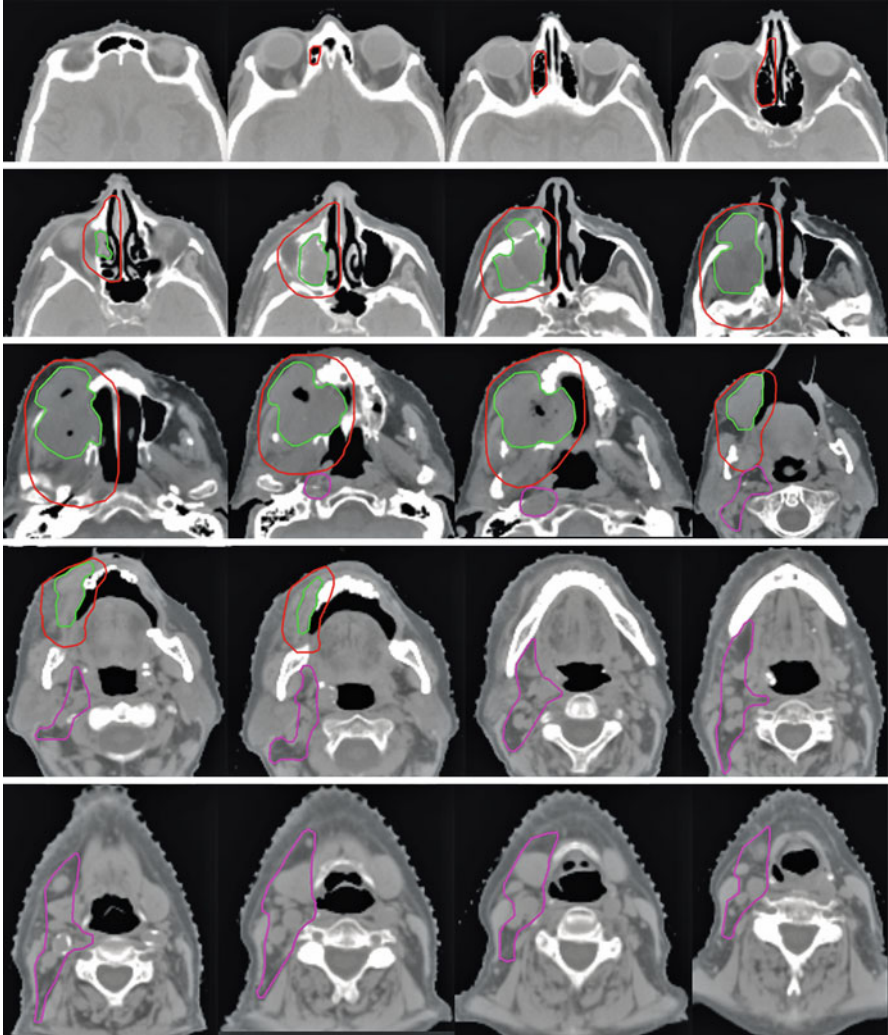


Fig. 6.1 An example of a 91-year-old patient with a cT4aN0 squamous cell carcinoma of the maxillary sinus. Patient refused surgery and was treated with definitive chemoradiation. The GTV is noted in the *green color* while the high-risk subclinical CTV is noted in the *red color*. Only the ipsilateral neck was included in the pink color given the lateralized right maxillary sinus location as well as the patient's advanced age

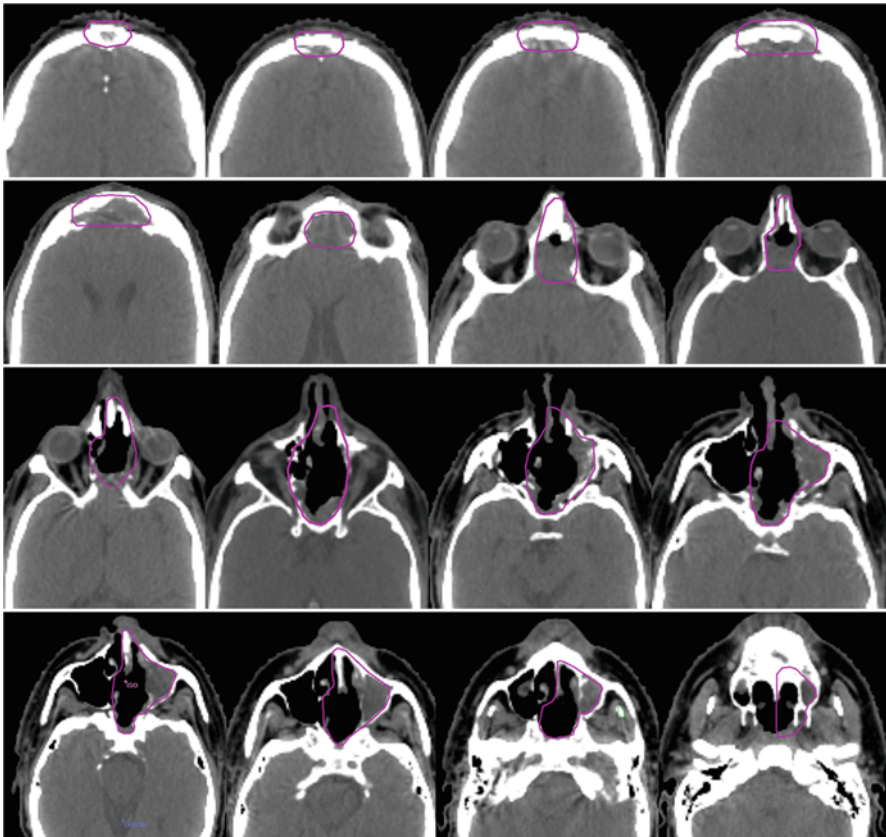


Fig. 6.2 An example of a 43-year-old patient with a pT4aN0 squamous cell carcinoma of the ethmoid sinus. Patient is s/p ethmoidectomy, sphenoidectomy, nasal exenteration, and anterior craniotomy. Patient then received adjuvant chemoradiation. The CTV is noted in the *pink color*. As this was a low-grade tumor with no neck involvement, no LN regions were treated

Further Reading

- Bristol IJ, Ahamad A, Garden AS et al (2007) Postoperative radiotherapy for maxillary sinus cancer: long-term outcomes and toxicities of treatment. *Int J Radiat Oncol Biol Phys* 68:719–730
- Chen AM, Daly ME, Bucci MK et al (2007) Carcinomas of the paranasal sinuses and nasal cavity treated with radiotherapy at a single institution over five decades: are we making improvement? *Int J Radiat Oncol Biol Phys* 69:141–147
- Le QT, Fu KK, Kaplan MJ et al (2000) Lymph node metastasis in maxillary sinus carcinoma. *Int J Radiat Oncol Biol Phys* 46:541–549