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INTENSITY-MODULATED RADIOTHERAPY (IMRT) FOR CARCINOMA OF THE MAXILLARY SINUS: A COMPARISON OF IMRT PLANNING SYSTEMS

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Abstract—The treatment of maxillary sinus carcinoma with forward planning can be technically difficult when the neck also requires radiotherapy. This difficulty arises because of the need to spare the contralateral face while treating the bilateral neck. There is considerable potential for error in clinical setup and treatment delivery. We evaluated intensity-modulated radiotherapy (IMRT) as an improvement on forward planning, and compared several inverse planning IMRT platforms. A composite dose-volume histogram (DVH) was generated from a complex forward planned case. We compared the results with those generated by sliding window fixed field dynamic multileaf collimator (MLC) IMRT, using sets of coplanar beams. All setups included an anterior posterior (AP) beam, and 3-, 5-, 7-, and 9-field configurations were evaluated. The dose prescription and objective function priorities were invariant. We also evaluated 2 commercial tomotherapy IMRT delivery platforms. DVH results from all of the IMRT approaches compared favorably with the forward plan. Results for the various inverse planning approaches varied considerably across platforms, despite an attempt to prescribe the therapy similarly. The improvement seen with the addition of beams in the fixed beam sliding window case was modest. IMRT is an effective means of delivering radiotherapy reliably in the complex setting of maxillary sinus carcinoma with neck irradiation. Differences in objective function definition and optimization algorithms can lead to unexpected differences in the final dose distribution, and our evaluation suggests that these factors are more significant than the beam arrangement or number of beams.

Key Words: **Radiotherapy, Radiation, IMRT, Intensity modulation, Maxillary sinus, Carcinoma, Inverse planning, Optimization.**

INTRODUCTION

Intensity modulation and conformal techniques have recently been shown to be of potential benefit in treating head-and-neck cancer in terms of guaranteeing adequate dose to the tumor volume as well as optimizing normal tissue dose. Inverse planned optimization appears to offer significant clinical improvement over forward planned conformal approaches.[1] Common techniques involve computed tomography (CT)-style delivery, often with a MIMiC multileaf collimator, as well as fixed beams with a dynamic multileaf collimator (MLC). In the majority of treated cases, a small target volume is the object of treatment, usually with adjacent critical structures. The clinical scenario is often one of retreatment for recurrent head-and-neck cancer. However, definitive and postoperative primary treatment is also feasible, and simultaneous elective neck radiation has also been shown to be feasible with promising preliminary clinical outcomes.[2,3]

The case of maxillary sinus cancer is ideally suited for inverse planning and intensity modulation. Historically, the primary tumor alone was targeted without specifically addressing the neck. The majority of recent intensity modulation publications for maxillary sinus largely ignore the neck.[4–6] However, over the past several years, it has been demonstrated that the neck failure rate is sufficiently high for this tumor site to warrant elective nodal irradiation. Neck failure rates are typically in the range of 20%, with reports ranging from 8% to 29%.[7–13]

Treating maxillary sinus cancer with elective radiation to the neck poses a difficult problem with conventional forward planning techniques. This difficulty is present with both primary radiation therapy and postoperative therapy. The primary problem arises from the desire to spare the contralateral side of the oral cavity, eye, and face, while treating both sides of the neck electively. This technical difficulty can be addressed with either a set of overlapping fields with partial transmission blocks, or multiple segmented fields. In the comparison case described here, a total of 12 fields were involved. This poses a significant potential for treatment errors as well as raising the possibility of unreliable dosimetry due to small field sizes matching over penumbras. The possibility that IMRT may be less error prone than conventional treatment has been noted.[3]

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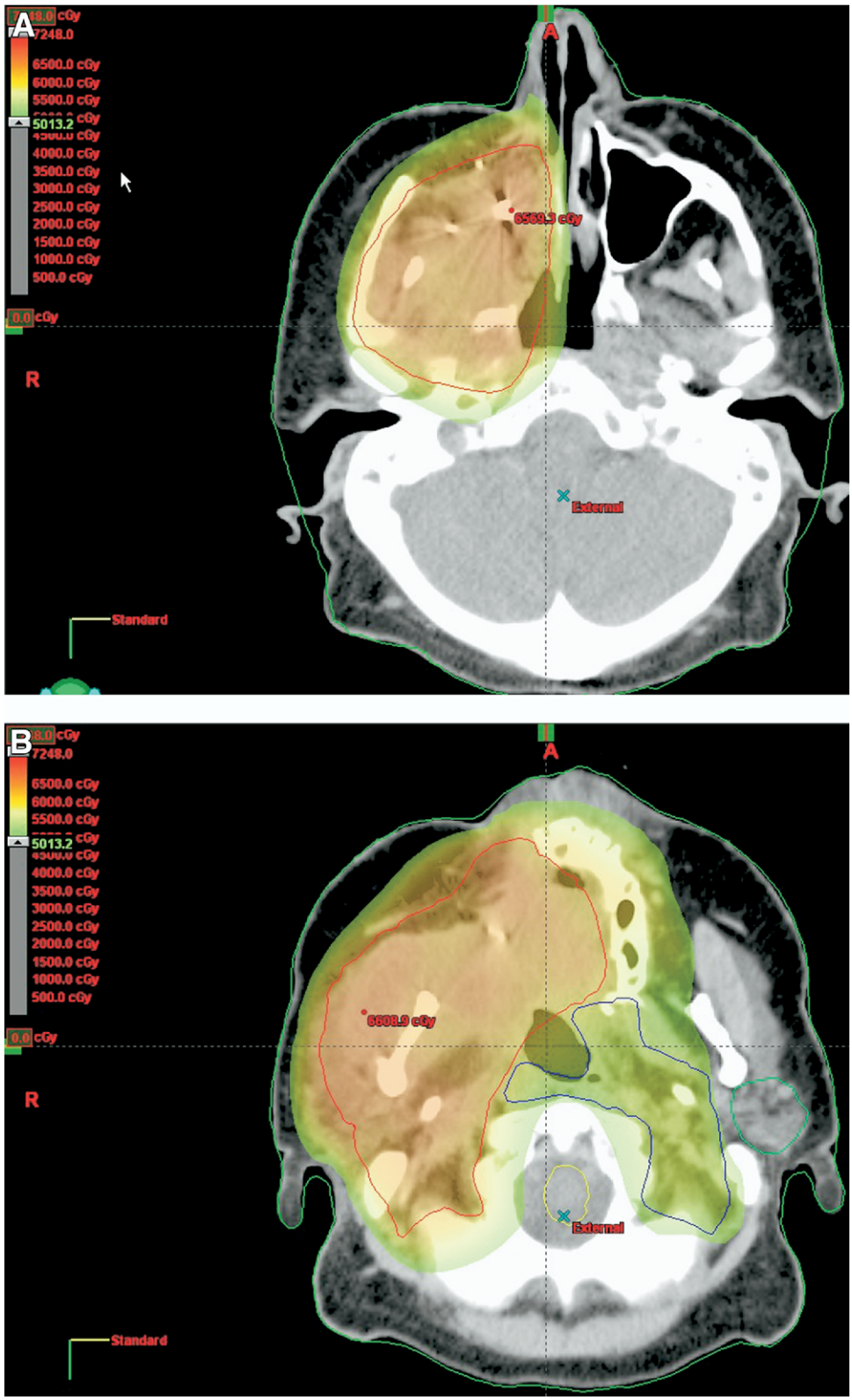

Fig. 1. Clinical target volumes are illustrated on representative CT slices at (A) the level of the maxillary sinuses, (B) the level of the maxilla, and (C) neck level 2. The right-sided volume represents the surgical bed and is quite extensive, and was expanded to generate the PTV60. The contralateral CTV included neck levels and retropharyngeal nodes at risk for microscopic disease, and was used to generate the target PTV50.