4. Sham, J.; Choy, D.; Kwong, P. W. K.; Cheng, A. C. K.; Kwong, D. L. W.; Yau, C. C.; Wan, K. Y.; Au, G. K. H. Radiotherapy for nasopharyngeal carcinoma: Shielding the pituitary may improve therapeutic ratio. Int. J. Radiat. Oncol. Biol. Phys. 29:699–704; 1994.

IN RESPONSE TO CHENG *ET AL.*

To the Editor: This letter is in response to the Letter to the Editor by Cheng *et al.* regarding shielding of the pituitary for nasopharyngeal carcinoma. The exclusion of patients with nasal or ethmoid involvement would not have been necessary if the pituitary shield in our protocol was not placed so that its anterior arm slants towards the anterior cranial fossa.

We were careful with these exclusions because we wanted to make sure that the advice derived from our study could easily be applied to benefit patients, including those residing in the high incidence areas in Asia where baseline investigation using computed tomography is not a routine.

We are also happy that the experience of Cheng *et al.* for T1–T3 tumor corroborated our result. However, we are of the opinion that prospective randomized and carefully controlled studies are required to document the safety of pituitary shielding for T4 tumors. We hope further prospective studies from Cheng et al. and other centers will define more clearly the possibility of excluding the pituitary–hypothalamus axis from the target volume, including patients with skull base erosion. We feel that, with improvement in imaging techniques, the goal for radiation therapy of NPC would be to deliver high-dose radiation to the tumor bearing area, while at the same time shielding the adjacent uninvolved normal tissues as much as possible.

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CONCERNS REGARDING TECHNIQUE USING PARALLEL-OPPOSED HIGH-ENERGY ELECTRON BEAMS FOR REIRRADIATION OF TUMORS NEAR THE SPINAL CORD (RECURRENT HODGKIN'S LYMPHOMA)

To the Editor: The technique reported by Gosselin *et al.* (1) describes an interesting technique that uses abutting parallel-opposed 20-MeV electron beams to treat recurrent Hodgkin's lymphoma in the mediastinum and hilum. The paper presents a methodology for optimizing the shape of a posterior cord block; however, the dose distributions fail to account for the effects of tissue inhomogeneities, which can result in doses as much as 30% greater than those reported by the authors.

It is a difficult, if not impossible task, to achieve dose uniformity (±10%) when abutting the distal falloff region of an electron beam to the dose gradient of another beam (opposed electron beam or orthogonal photon beam), particularly in the presence of tissue inhomogeneities. In the technique by Gosselin *et al.*, an anterior 20-MeV electron beam is abutted to a parallel-opposed 20-MeV electron beam in the mediastinum. The depth-dose gradient of a 20-MeV electron beam in water is approximately 25% per cm at R_{50}. Internal inhomogeneities (particularly lung) can significantly alter the shape of the dose distribution (2). In the results reported by Gosselin *et al.*, the patient has been assumed to be water equivalent, thus producing erroneous results in the actual patient. This problem has been masked by the authors' use of a dose distribution measured in a homogeneous polystyrene phantom superimposed on an inhomogeneous transverse computed tomography (CT) image of the patient.

To illustrate our point, we have evaluated the dosimetry using inhomogeneity corrections. We scaled the transverse CT image from Gosselin *et al.* to have a midline diameter of 17 cm and entered it into a treatment planning computer.[1] Lung was assigned a density of 0.3 and the vertebral column a density of 1.2. The 1.4-cm-wide posterior cord block was modeled in the treatment planning system as a dense internal inhomogeneity. Dose distributions were calculated for parallel-opposed 20-MeV electron beams 12-cm wide by 20-cm long. The 20-MeV beam used in our calculation was from the same accelerator[2] as that reported by Gosselin *et al.* and was essentially identical. For electron dose calculations, the treatment planning system used a two-dimensional (2-D) pencil-beam algorithm (3, 5, 6).

We first calculated the dose distribution assuming the patient was water. The resulting dose distribution is plotted in Fig. 1 and is similar to the dose distribution described by Gosselin *et al.*, which was measured in a homogeneous polystyrene phantom (17 cm thick) and superimposed onto the patient's transverse CT image. Gosselin *et al.'s* measurements ignored the irregular surface of the patient; therefore, there are some significant differences. Specifically, the central-axis dose approximately midway through the patient is as much as 10% less in our calculation. This is a result of the increased patient diameter off-axis, from which scattered electrons reaching central axis have a greater effective depth. Off-axis doses in the mediastinum are as much as 20% less than those reported by Gosselin *et al.*, also a result of the increased patient diameter off-axis.

We then calculated the dose distribution, accounting for internal inhomogeneities. The resulting dose distribution is plotted in Fig. 2. Results show this dose distribution was substantially different from that in Fig. 1, in which the patient was considered to have the homogeneity of water. Dose in the lateral regions of the target volume has increased from 80 to 130%. Compared to the results of Gosselin *et al.*, the volume of irradiated lung increased, and the dose to lung in the treatment fields increased by as much as 30%. Although Gosselin *et al.* reported no radiation-induced complications 20 months post-treatment from the 30-Gy dose delivered, an increased dose would increase the risk of radiation damage, particularly to lung, and longer follow-up may demonstrate this.

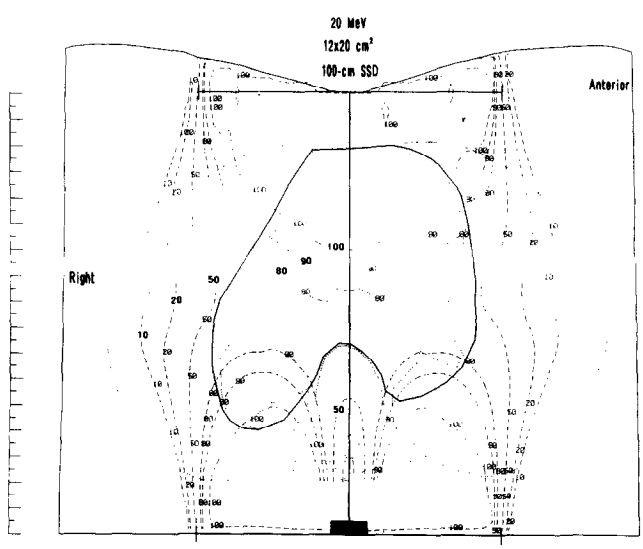

Fig. 1. Dose distribution calculated by 2-D pencil-beam algorithm assuming patient is water. The area was irradiated by two equally weighted parallel-opposed 20-MeV electron beams. The fields were 12 cm wide by 20 cm long; the posterior field had a 1.4-cm-wide cord block. The patient's anatomy was extracted from an enlargement of the figure in Gosselin *et al.* that contained the central-axis CT slice, assuming a 17-cm anterior–posterior diameter on central axis. Outlines of both lungs and the vertebral column are shown as dotted contours. Isodose contours are dashed, and their dose values are a percentage of given dose from a single beam.

[1] General Electric Target II, General Electric Medical Systems, Waukesha, WI.

[2] Varian Clinac 2100C, Palo Alto, CA.