Penn Medicine

CLINICAL BRIEFING™

Department of Radiation Oncology • Abramson Cancer Center

Proton Therapy for Advanced Cancers of the Head and Neck

Radiation-oncologists at Penn Medicine have introduced proton therapy (PT) as an option for the treatment of advanced salivary gland cancers, tongue-base and tonsil cancers, skull-based malignancies and recurrent cancers of the head and neck.

The prevailing complication for standard radiation treatment of advanced head and neck cancers is the intrinsic proximity of critical organs that are highly sensitive to radiation, including the brain, brainstem, spine, salivary glands and swallowing structures. Classic radiation treatment protocols must thus consider whether the minimum exposure required to adequately treat a malignancy will prove toxic to nearby normal organ tissues. Radiation overexposure can cause loss of sensory function, impaired salivary production and swallowing capacity, as well as neurological damage and the risk of secondary cancers. However, efforts to minimize exposure outside of the target lesion that result in the inadequate delivery of therapeutic doses may increase the risk of cancer recurrence.

It is thought that the physical properties of proton therapy may offer unique advantages for the treatment of head and neck cancers. Among the most important of these is rapid dose fall off at the distal edge of the target (Bragg-Peak effect), a characteristic that allows for significant reductions in radiation dose to normal organs, improved dose homogeneity and the potential for dose escalation. Dosimetric studies of head and neck cancer patients comparing intensity-modulated forms of standard radiation therapy (IMRT) to proton therapy (IMPT), have demonstrated that critical organs were optimally spared with IMPT, with lower estimated secondary cancer risks as a result of lower integral dose received by normal tissue.[1]

Through the Roberts Proton Therapy Center at Penn Medicine, patients with head and neck cancers are being treated in clinical studies to confirm whether the dosimetric advantages of proton therapy shown in previous studies will translate to gains in treatment outcome and patient-reported improvements in side effects and quality of life.

Patients with salivary gland malignancies are currently treated with **double scattering proton therapy.** Compared to IMRT, proton therapy can decrease dose to adjacent normal organs and limit the area of low dose radiation delivered to normal tissues (Figure 1). These dosimetric gains could potentially translate to improved long-term results such as decreasing rates of chronic xerostomia and radiation-induced secondary malignancies.

Many patients with cancers of the base of tongue and tonsils are being treated with **pencil beam scanning proton therapy** at the Roberts Center in collaboration with the Departments of Otorhinolaryngology-Head and Neck Surgery and Medical Oncology. Patients are treated initially with a minimally-invasive approach via **TransOral Robotic Surgery** (**TORS**). For patients who then require additional treatment, proton therapy is a promising option, one which maintains a high rate of cancer cure with potential gains in lessening the traditionally-observed side effects associated with radiation therapy.

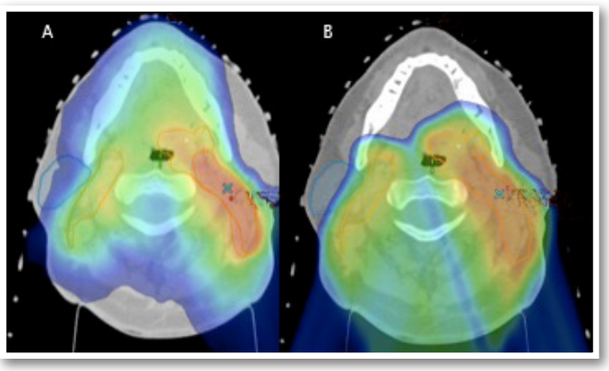

Figure 1: Conformal dose patterns for a patient with tonsillar cancer demonstrating radiation exposure to the head and neck for (A) standard radiation therapy and (B) proton therapy.

Pencil beam scanning PT is also being used at Penn for the treatment of base of skull malignancies. Treatment of tumors at this particular site with conventional radiation has traditionally been limited by an inability to deliver adequate doses of radiation without exceeding constraints on critical structures in the brain and optic apparatus. Pencil beam scanning allows for enhanced conformal dose around critical structures through modulation of dose in depth, while retaining the rapid dose fall-off from the Bragg-Peak effect.

Re-irradiation with proton therapy for recurrent head and neck cancer is being investigated at Penn Medicine in clinical trials with the hope that improving coverage of affected areas while minimizing normal tissue toxicity can inhibit treatment-related morbidity and improve clinical outcomes in a population that otherwise has limited options. In a previous study,[2] overall survival at two years among patients re-irradiated with protons for recurrent nasopharyngeal carcinoma was approximately 50%. Two-year survival was significantly higher in those with "optimal" dose-volume histogram coverage versus those with "suboptimal" coverage (83% and 17%, respectively, P=0.006).

References

1. Steneker M, Lomax A, Schneider U. Intensity modulated photon and proton therapy for the treatment of head and neck tumors. Radiother Oncol 2006;80:263-7.

2. Lin R, Slater JD, Yonemoto LT, et al. Nasopharyngeal carcinoma: repeat treatment with conformal proton therapy–dose-volume histogram analysis. Radiology 1999;213:489-494.

Case Study

Mr. V, a 54-year-old man, was referred to an otorhinolaryngologist at Penn Medicine after presenting to his personal physician with a mass in his left neck mass. At Penn, a CT scan found a 3.3 cm lesion at the left lingual tonsil; a subsequent needle biopsy determined that the mass was an HPV-positive tonsillar cancer. Mr. V was scheduled for a TransOral Robotic Surgery (TORS) procedure to remove the lesion (T2 stage), followed by a left neck dissection, which found multiple nodes positive for stage 4A tonsillar cancer. Considered a good candidate for proton therapy, Mr. V was treated post-operatively with PT to limit morbidity associated with radiation therapy and enhance his outcome.

Mr. V's recovery was unremarkable, and he did well throughout his PT therapy, experiencing only mild and transient changes in taste (with return to normal by 6 weeks) and no weight loss as a result of treatment. He returned to work soon afterward, and remains cancer free at one year post-surgery.

Faculty Team

Among the largest and most respected programs in the world, Penn Radiation Oncology offers a variety of innovative treatment options to patients with cancer. In addition, as a national leader in basic science, translational research and clinical trials, Penn Radiation Oncology offers patients access to the latest treatment options—including proton therapy—before they are widely available elsewhere.

Performing Proton Therapy for Head and Neck Cancers at Penn Medicine

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Clinical Research at the Roberts Proton Therapy Center

The Roberts Proton Therapy Center has the advantage of being part of a world class academic medical center, Penn Medicine, and an NCI-designated Comprehensive Cancer Center, Penn's Abramson Cancer Center. In addition to its primary mission of improving the treatment of cancer, however, the Roberts Center has the purpose of expanding, defining and clarifying the therapeutic uses for proton therapy through clinical research.

Recent clinical protocols have sought to increase and enhance the effectiveness of proton therapy and to determine which cancers should be treated with proton versus conventional radiation.

In addition to head and neck cancers, the conditions currently being investigated at the Roberts Center include seminoma and cancers of the prostate, breast, lung and abdomen. For more information about the Roberts Proton Therapy Center, visit: PennMedicine.org/ProtonTherapy.

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