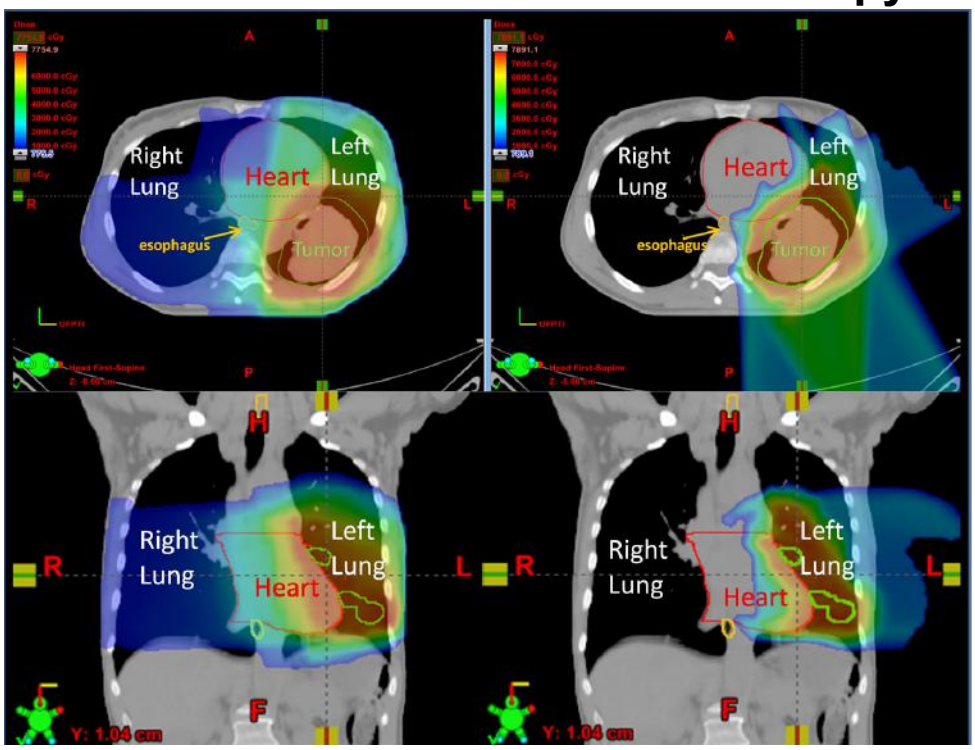
UFHealth
PROTON THERAPY INSTITUTE

Image-Guided Proton Therapy for Lung Cancer and Thymoma

Proton therapy provides patients a non-surgical treatment approach for the management of their lung cancer. Proton therapy is an alternative form of radiation that is different from traditional high-energy X-ray radiation (or photons). Due to proton therapy's unique properties, it can deliver the radiation dose to a specific depth in the body and then stop. X-ray radiation, on the other hand, continues to penetrate through normal tissue and organs (such as lungs, heart, esophagus, and spinal cord), causing damage and toxicity. Below are some CT images that illustrate radiation exposure for the same patient with both an intensity-modulated X-ray radiotherapy (IMRT) plan (left) and a proton therapy plan (right). The color wash represents high radiation doses in red, medium doses in yellow and green, and low doses in blue. As you can see, for this patient, the proton plan substantially reduces the radiation dose to the lung (the black area in the chest), esophagus(outlined in orange), and heart (out lined in red). Lower doses to these regions will reduce the risk of radiation-induced pneumonia, breathing trouble, pain with swallowing, and cardiac disease.

IMRT **Proton Therapy**



Stereotactic Body Proton Therapy for Stage I Non-Small Cell Lung Cancer (NSCLC)

(Treatment length: 1-2 weeks)

At the University of Florida Health Proton Therapy Institute, patients with stage I NSCLC receive hypofractionated proton therapy. This means that we deliver the full course of treatment over just one to two weeks. Proton therapy is especially helpful in patients with stage I lung cancer that is located close to the center of the chest and for larger tumors, which are more difficult to treat with short courses of X-ray radiotherapy. We have shown that proton therapy reduces the dose to the lung, esophagus, heart, skin, and bones compared with stereotactic body radiotherapy using X-rays. Proton therapy treatment has been successfully used for stage I lung cancer at other proton centers in Japan and California for over 10 years with tumor control rates of over 90%. We have an active protocol studying quality of life in patients receiving this treatment.

Publications of Interest:

Hoppe BS, Huh S, Flampouri S, Nichols RC, Oliver KR, Morris CG, Mendenhall NP, Li Z. Double-scattered proton-based stereotactic body radiotherapy for stage I lung cancer: a dosimetric comparison with photon-based stereotactic body radiotherapy. *Radiother Oncol*. 2010 Dec; 97(3):425-30.

Grutters JP, Kessels AG, Pijls-Johannesma M, De Ruysscher D. Joore MA, Lambin P. Comparison of the effectiveness o f r adiotherapy with photons, protons, and carbon-ions for non-small cell lung cancer: a meta-analysis. *Radiother Oncol*. 2010 Apr; 95(1):32-40.

Stage II & III Non-small Cell Lung Cancer (NSCLC)

(Treatment length: 4-8 weeks)

In patients with stage II and III lung cancer, surgery is often not an option because of the extent of involvement of the lung cancer or because the patient has other medical problems, making surgery too difficult. Proton therapy in combination with chemotherapy offers an aggressive approach for managing these patients. In addition to treating less normal tissue, which reduces the risk of painful swallowing and radiation-induced pneumonia, proton therapy may also allow us to deliver higher doses of radiation to the cancer with the goal of achieving better cure rates. This treatment approach has been succesfully used since 2008 at the University of Florida, MD Anderson Cancer Center (Texas), and Loma Linda University (California). We have active treatment protocols investigating radiation dose intensification with proton therapy to improve cure rates. Concurrent chemotherapy and most recently, immunotherapy, can be delivered by our medical oncology staff at UF Health.

Publications of Interest:

Hoppe BS, Flampouri S, Henderson RH, Pham D, Bajwa AA, D'Agostino H, Huh SN, Li Z, Mendenhall NP, Nichols RC. Proton therapy with concurrent chemotherapy for non-small-cell lung cancer; technique and early results. *Clin Lung Cancer.* 2012 Sep; 13(5):352-8.

Nichols RC, Huh SN, Henderson RH, Mendenhall NP, Flampouri S, Li Z, D'Agostino HJ, Cury JD, Pham DC, Hoppe BS. Proton radiation therapy offers reduced normal lung and bone marrow exposure for patients receiving dose-escalated radiation therapy for unresectable stage III non-small-cell lung cancer: a dosimetry study. *Clin Lung Cancer*. 2011 Jul; 12(4):252-7.

Chang JY, Komaki R, Lu C, Wen HY, Allen PK, Tsao A, Gillin M, Mohan R, Cox JD. Phase 2 study of high-dose proton therapy with concurrent chemotherapy for unresectable stage III nonsmall cell lung cancer. *Cancer*. 2013 Oct; 117(20):4707-13.

Sejpal S, Komaki R, Tsao A, Chang JY, Liao Z, Wei X, Allen PK, Lu C, Gillin M, Cox JD. Early findings on toxicity of proton beam therapy with concurrent chemotherapy for non-small cell lung cancer. *Cancer*. 2011 Jul; 117(13): 3004-13.

Small Cell Lung Cancer

(Treatment length: 6-7 weeks)

In patients with limited-stage small cell lung cancer, combined treatment of concurrent proton therapy with chemotherapy provides patients with an aggressive treatment regimen that can be less toxic than conventional X-ray radiation. This regimen could make the treatment more tolerable with less side effects, such as painful swallowing and radiation-induced pneumonia.

Publications of Interest:

Colaco RJ, Huh S, Nichols RC, Morris CG, D'Agostino H, Flampouri S, Li Z, Pham DC, Bajwa AA, Hoppe BS. Dosimetric rationale and early experience at UFPTI of thoracic proton therapy and chemotherapy in limited-stage small cell lung cancer. *Acta Oncologica.* 2013 Feb; 52(3): 506-13.

Thymoma

(Treatment length: 5-7 weeks)

In patients with resectable thymoma, proton therapy can be used to help reduce the risk of a recurrence following surgical resection. In patients with unresectable thymoma, proton therapy can be used with chemotherapy as potentially curative therapy. Proton therapy helps reduce the radiation dose to the heart and lungs compared with IMRT in patients with thymoma. In young women, it can help reduce the dose to the breasts. These lower doses should reduce the risk of toxicity from radiation, including cardiac disease, lung disease, and breast cancer.

Publications of Interest:

Figura N, Hoppe BS, Flampouri S, Su Z, Osian O, Monroe A, Nichols RC. Postoperative proton therapy in the management of stage III thymoma. *Journal of Thoracic Oncology*. 2013 May; 8(5):e38-40.

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