Penn Medicine

CLINICAL BRIEFING™

Penn Lung Center • Division of Thoracic Surgery

Intraoperative Molecular Imaging Detects Residual Tumor Cells During Lung Cancer Surgery

At Penn Medicine, surgeons are using molecular imaging technology to prevent cancer recurrence by improving the detection of residual cancer cells during surgery.

Complete surgical resection is substantially more effective than chemotherapy or radiation therapy for almost all solid tumors, and surgery is the most important predictor of long-term survival in cancer patients in the United States. However, the overall success of cancer surgery is diminished by local recurrence in up to a third of patients.

Recurrence is typically due to malignant cells that remain in the surgical field even when the algorithm for their eradication involves meticulous resection at the surgical margins, excision of both involved lymph nodes and satellite lesions, and the use of intraoperative frozen sectioning by pathologists to ensure the complete eradication of cancer during surgery. That these efforts so often fail demonstrates the challenge of identifying invasive and occult cancer cells through traditional observation and palpation during surgery.

To improve the long-term efficacy of cancer surgery, thoracic surgeons and radiation oncologists at Penn Medicine are using investigational intraoperative imaging systems that visually enhance residual cancer cells and the abnormal tissue densities typical of malignant lesions. These systems use fluorescent contrast agents that have an organic tropism for cancer cells, and that once absorbed, glow under certain lighting conditions, thus permitting lesions and cancerous cells to be identified and readily removed.

Using these systems in separate applications during surgery, the team at Penn Medicine has identified nodules as deep as 1.3 cm from the surface of solid organs and as small as 0.2 cm in size, as well as nodules in organs other than that of the primary tumor. In addition, cancer cells that are invisible to optical observation have been identified at the margins of surgery in lung cancer patients.

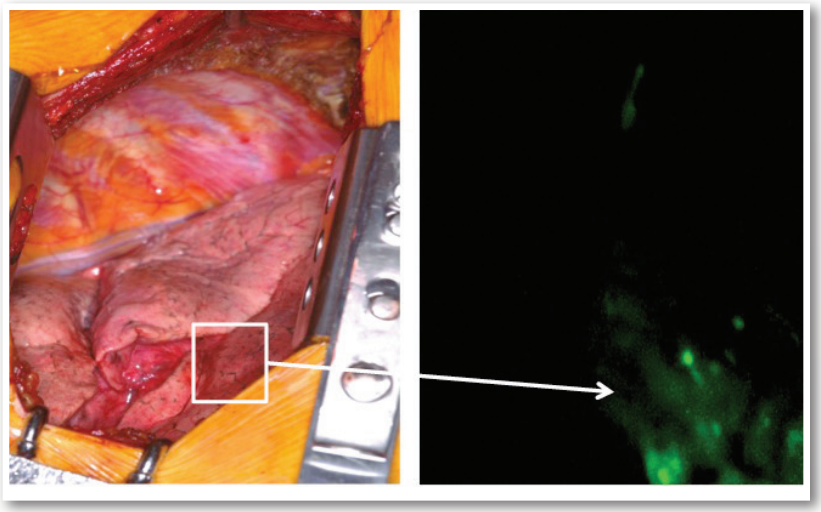

Figure 1: A small lesion (0.7 cm) appears under near-infrared light in the lower left lobe of a patient thought to have Stage IA pulmonary adenocarcinoma. The lesion was undetected by PET/CT scan and visual examination; this patient was subsequently re-staged to stage IIIA.

CASE STUDY

Mrs. M, a 64-year-old woman, was referred to Penn Thoracic Surgery for evaluation following six-months of persistent cough and bronchial irritation. Mrs. M had never smoked, and with the exception of hypertension, her medical history was unremarkable. A chest x-ray at Penn revealed a mass (>3.5 cm) in the upper lobe of her left lung in close proximity to the pleura. A PET/CT scan found no evidence of spread to nearby lymph nodes or metastases. A transthoracic needle aspiration biopsy of the mass revealed malignant cells, and a histological analysis identified a moderately-differentiated cancer with clear cell features consistent with a primary pulmonary adenocarcinoma. Cytogenetic analysis was negative for EGFR/Kras mutations and ALK rearrangement. There was no evidence of metastases. Mrs. M's cancer was classified as a surgically resectable Stage IA pulmonary adenocarcinoma.

After a discussion during which Mrs. M expressed apprehensions about cancer recurrence based on personal experience, she provided her informed consent to take part in the fluorescent image-guided investigation.

Prior to surgery, Mrs. M underwent CT scanning. The scan was reviewed by a radiologist to confirm the presence of a solitary pulmonary nodule. Twenty-four hours before her surgery, an intravenous contrast agent was administered.

During her surgery, surgeons located the identified primary nodule using visual inspection and manual palpation. Following an inspection of the ipsilateral lung that found no other lesions, the operating room lights were removed, and the near-infrared spectroscopy (NIR) imaging system was sterilely draped and positioned above the chest.

The primary nodule was imaged and photo-documented by white light and fluorescence. The imaging system was then used to search for additional nodules in her lung, subsequently identifying a single small (0.7 cm) lesion in the lower lobe of her left lung (Figure 1) close to the pleural surface, and two lymph nodes near the original primary tumor. Both lesions and the lymph nodes were removed and re-imaged for confirmation in the operating room before being submitted to pathology. Mrs. M's cancer was then re-staged to stage IIIA.

(Case study continued on back page)

(Case Study continued from front)

Mrs. M remained in the hospital for two days following her surgery and was discharged home. Her recovery was unremarkable. She received adjuvant chemotherapy and radiaton therapy without significant morbidity. At her six-month and one-year follow-up visits, x-rays and CT/PET scans found no evidence of recurrent cancer.

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FACULTY TEAM

The lung cancer team at Penn Medicine is leading an effort to revolutionize the early diagnosis, prevention and treatment of lung cancer. Penn is a major center for lung cancer clinical trials, allowing patients to benefit from the newest and best therapies available.

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FY17-12337 10.16