Argonne NATIONAL LABORATORY

Technology Development & Commercialization

Endoscopic Electron Beam Cancer Therapy

Improved Treatment of X-ray Resistant & Inoperable Cancers and Tumors

Manipulating electron beam cancer therapy so it can be used treat internal cancers and tumors has the potential to revolutionize oncology. This ground-breaking innovation can provide a successful and cost-effective means of treating cancer in previously inoperable or radiation-sensitive areas of the body.

Technology Description

By delivering large irradiation doses in a short time, electron beams have proven to be very effective in cancer treatment. But the electron is also strongly absorbed by tissue, limiting this treatment to surface cancers and procedures that require large surgical incisions to expose the body core.

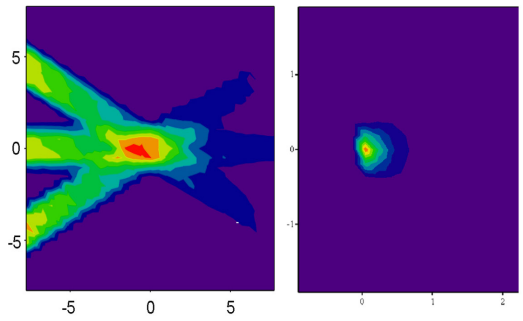
Researchers at Argonne National Laboratory, led by John Noonan, have discovered a way to turn the negative attributes of electron beam cancer therapy into advantages. If the electron beam can be transported to the internal cancer without exposure to tissue, the beam can be absorbed by the tumor only. With this approach, healthy tissue is not exposed to radiation.

An electron source has been designed to have very low beam emittance. The beam is sub-millimeter in diameter and stays small over meters of transport in free space. It will allow for an articulated, hard-walled laparoscopic tube to be inserted through a small incision and positioned directly at the tumor. The beam can vary energy from 1 million electron volts (MeV) to 10 MeV, permitting it to cover a tumor size of about 0.5 cm to 5 cm, respectively.

Initially, electron beam treatment can be used on X-ray radiation resistant tumors. The electrons destroy cancerous cells by direct damage to the DNA, and not by electron displacement in molecules as with X-rays. Ultimately, the electron beam therapy would be a competitor to all X-ray treatments.

Potential Benefits

The damage volume of the electron irradiation can be controlled very closely by changing the electron beam energy. This precise exposure provides several new cancer therapies or treatments in previously inoperable or radiation-sensitive locations, such as the spine, nerves, optic nerve, and organs. Electron beam treatment of brain tumors is another new opportunity. In this case, the laparoscopic tube provides an advantage. After the irradiation, the tube can be used to evacuate the mass of dead tissue, which can become destructive to healthy brain cells.



This figure shows a comparison of X-ray radiation treatment and electron beam treatment. At left, a false color map displays energy deposited into tissue as a function of distance for three 250-kV X-ray beams. At right, the map displays energy deposited into tissue for a 3-MeV electron beam as a function of distance, with the zero point starting at the end of the laparoscopic tube (note length scale change).

Enormous doses can be delivered to the tumor without worrying about total body dose exposures, as is required for X-rays. The electron beam can be tailored to irradiate a very precise volume, so an oncologist can direct the irradiation at the tumor and whatever adjacent tissue they feel necessary. Another major advantage over X-rays is the amount of treatment time required. X-ray treatments can go on for months, while electron beams may potentially only require one session, providing a significant improvement in patient care.

The electron beam system is compact so it could fit in an operating room—probably even under the operating table. Except for the electron source, the system uses conventional accelerator technology. The production cost of the unit should be much less than that of existing radiation therapy systems.

Technology Area: Medical Devices
Product: Electron beam machine for cancer therapy
Development Stage: Proof of concept
Primary Inventors: John Noonan, noonan@anl.gov
Scientific Publication: Noonan J., and Lewellen J.W., 2005, "Field-emission cathode gating for RF electron guns," *Physical Review, Special Topics - Accelerators and Beams* 8: 033502.
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