

Proton Therapy BACKGROUND

What is it?

Proton therapy is a kind of external beam radiotherapy where protons are directed at a tumor site.

Proton therapy is so effective because of its ability to accurately target and kill tumors, both near the surface and deep seated within the body, while minimizing damage to the surrounding tissues. For this reason, it is favored for treating certain kinds of tumors where conventional X-ray and radiation oncology would damage surrounding tissues to an unacceptable level. This is especially a problem around optical nerves, the spinal cord/central nervous system, head and neck areas, and the prostate. This is also particularly important for pediatric patients where long term side effects, such as residual occurrence of secondary tumors resulting from the overall radiation dose to the body, are of great concern. Because of the lower dose to healthy tissue, protons have less severe side-effects than conventional radiation therapy.

How it works

Protons exist in the nuclei of atoms and have electrons orbiting them. For radiation therapy, physicists separate positively charged protons from hydrogen atoms by stripping off the negatively charged electrons. Powerful magnets then bend the proton stream in to a circular path and then control then it as the stream is accelerated to near light speed inside a cyclotron. The speed of the resulting beam, and therefore its energy, is measured in electron volts, and the higher the electron voltage, the heavier the impact when the beam hits a tumor in a patient's body.

Proton therapy, like all forms of radiation therapy, works by aiming the energized particles – in this case protons – onto the target tumor. These particles damage the DNA of cells, ultimately causing their death. Because of their high rate of division, and their reduced ability to repair damaged DNA, cancerous cells are particularly vulnerable to this attack on their DNA.

The difference in the effectiveness of protons and X-rays is what takes place before and after radiation reaches the tumor. X-rays release much of their energy quickly after penetrating the skin, disrupting the molecules of healthy tissue and organs. Protons can be manipulated to release most of their energy only when they reach their target. Unlike X-rays, which pass completely through the body, protons go no farther than the tumor, sparing everything behind it. More energy reaches the cancerous cells, so more damage is administered by each burst of radiation. Side effects caused by the irradiation of normal tissue in front of and behind the tumor are not totally eliminated, but dramatically reduced.

Quick History of Proton Therapy in the U.S.

- 1936 – Ernest Lawrence invents the Cyclotron
- The first suggestion that energetic protons could be an effective treatment method was made by Robert R. Wilson in a paper published in 1946 while he was involved in the design of the Harvard Cyclotron Laboratory

- In 1961, a collaboration began between the Harvard Cyclotron Laboratory and Massachusetts General Hospital to pursue proton therapy
- 1970's – Massachusetts General Hospital conducts first study on mixed proton/photon radiotherapy for the treatment of prostate cancer
- 1980's – Design and construction began on the 1st dedicated clinical facility for the Proton Therapy Treatments at Loma Linda Medical Center in CA
- 1990's – over 25,000 patients treated throughout the worlds with proton therapy

Why use Protons?

- Same tumor killing properties as X-rays
- Decreased dose to normal tissues by 50-70%
- Decreased side-effects and complications
- Ability to treat tumors close to critical organs like the spinal cord
- With X-rays, 20% of cancers come back because treatment dose was too low to be effective
- Possibility to increase the safe dose delivered to tumors
- Possibility of increased cure rates
- The ability to re-treat tumors after recurrences
- The added ability to treat benign conditions

Applications of Protons to Treat Cancers

- Head & neck cancers
- Prostate Cancer
- Brain & spinal tumors
- Lung cancer
- Gastrointestinal Cancers
- Cancers that cannot be removed completely by surgery
- Pediatric Cancers

Applications of Protons to Treat Benign Conditions

- Parkinson's Disease
- Seizure Disorders – Epilepsy
- Prevention of Coronary Restenosis
- Severe Rheumatologic Conditions
- Arteriovenous Malformations
- Macular Degeneration