Proton Therapy:
Cutting Edge Treatment for Cancerous Tumors

By:

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Introduction

Put simply, proton therapy is a new cutting edge cancer treatment that promises better outcomes for patients undergoing cancer treatment, with the potential for fewer side effects. Proton therapy has benefits over conventional therapy in the treatment of many common cancers, including prostate cancer, cancer in children, lung cancer, cancers of the eye, and many more.

Proton Therapy Momentum

Since 1954, when proton beam radiation therapy was first introduced for human treatment, about 55,000 patients have been treated in the United States and around the world. The United States currently has five full-scale operating proton facilities. Future proton centers now in the development stage include: Hampton University in the Tidewater VA area, University of Pennsylvania Medical Center, Seattle Washington's Cancer Care Alliance, Northern Illinois University and Oklahoma City.

Operating Facilities	Facilities in Development
Loma Linda University Medical Center in California	Northern Illinois Proton Therapy Facility
Francis H. Burr Proton Center in Massachusetts	University of Pennsylvania
Midwest Proton Radiotherapy Institute in Indiana	Hampton University in Virginia
M.D. Anderson in Texas	Seattle Washington Cancer care Alliance
University of Florida Proton Therapy Institute	Oklahoma City

Proton Therapy Basics

Proton therapy is a pinpoint accurate radiation treatment that delivers the exact dose of radiation needed to treat a tumor. Proton therapy, like all forms of radiotherapy, works by aiming energetic ionizing particles onto the target tumor. However, unlike traditional radiation, proton therapy utilizes proton ionization rather than x-ray ionization.

Essentially, protons are a superior form of radiation therapy. Fundamentally, all tissues are made up of molecules with atoms as their building blocks. In the center of every atom is the nucleus. Orbiting the nucleus of the atom are negatively charged electrons. When energized charged particles, such as

protons or other forms of radiation, pass near orbiting electrons, the positive charge of the protons attracts the negatively charged electrons, pulling them out of their orbits. This process is called ionization.

Ionization changes the characteristics of the atom and consequentially the character of the molecule within which the atom resides. This crucial change is the basis for the beneficial aspects of all forms of radiation therapy. As a result of ionization, the radiation damages molecules within the cells, especially the DNA or genetic material. Damaging the DNA destroys specific cell functions, particularly the ability to divide or proliferate. Enzymes develop with the cells and attempt to rebuild the injured areas of the DNA; however, if damage from the radiation is too extensive, the enzymes fail to adequately repair the injury. While both normal and cancerous cells go through this repair process, a cancer cell's ability to repair molecular injury is frequently inferior. As a result, cancer cells sustain more permanent damage and subsequent cell death than occurs in the normal cell population. This permits selective destruction of bad cells growing among good cells.

How Proton Therapy Differs from Traditional Radiation Therapy

There is a significant difference between standard (x-ray) radiation treatment and proton therapy. Standard x-ray radiation techniques will control many cancers if given in sufficient doses. However, because of a physician's inability to adequately conform the irradiation pattern to the cancer, healthy tissues surrounding the tumor may receive a similar dose and can be damaged. Consequently, with standard radiation, a less than desired dose is frequently used to reduce damage to healthy tissues and avoid unwanted side effects. The power and benefit of proton radiation therapy is that higher doses of radiation can be used to control and manage cancer while significantly reducing damage to healthy tissue and vital organs.

While both standard x-ray therapy and proton beams work on the principle of selective cell destruction, proton therapy has major advantages over traditional x-ray radiation. The major advantage of proton treatment over conventional radiation is that the energy distribution of protons can be directed and deposited in tissue volumes in a three dimensional pattern from each beam used. In other words, the proton beam can be contoured to conform to the exact shape of the tumor, enabling even greater accuracy. This capability provides greater control and precision and, therefore, superior management of treatment.

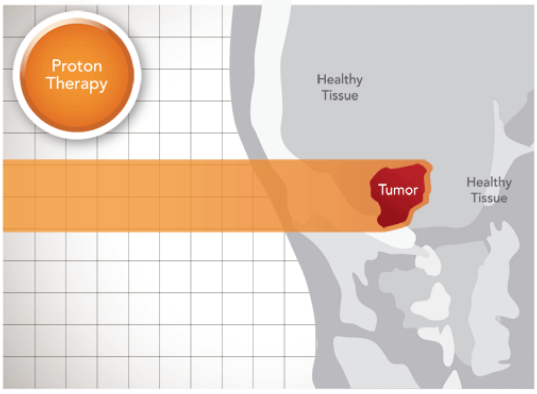
Radiation therapy requires that conventional x-rays be delivered into the body in total doses sufficient to assure that enough ionization events occur to damage all the cancer cells. The conventional x-rays lack of charge and mass, however, results in most of their energy from a single conventional x-ray beam being deposited in normal tissues near the body’s surface, as well as undesirable energy deposition beyond the cancer site. This undesirable pattern of energy

placement can result in unnecessary damage to healthy tissues, often preventing physicians from using sufficient radiation to control the cancer.

Protons, on the other hand, are energized to specific velocities and are more precisely targeted than x-rays. These energies determine how deeply in the body protons will deposit their maximum energy. Therefore, protons cause less damage to healthy tissue as they enter the body and deposit the majority of their destructive energy at the tumor site. Once this energy has been deposited at the tumor site, there is no additional damage to the healthy tissue behind the tumor as there is no exit dose of radiation beyond the tumor with proton therapy. This phenomenon is known as the Bragg Peak.

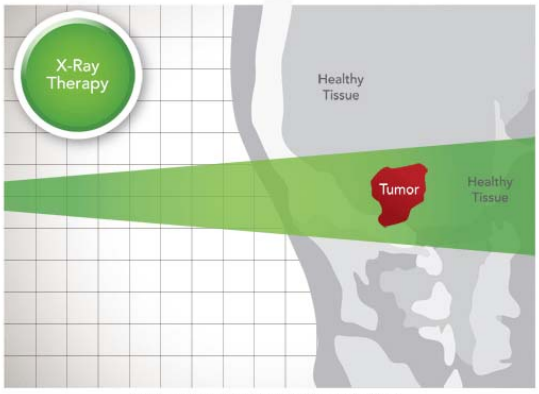
PROTON THERAPY VS. TRADITIONAL X-RAY RADIATION THERAPY

Proton Therapy



- A lower dose of radiation is released at the surface, but a sharp burst of radiation is released as the proton beam reaches the tumor site.
- Proton radiation stops at the tumor, leaving the healthy cells beyond it unaffected.
- The proton beam can be contoured to the exact shape of the tumor, further decreasing radiation exposure and limiting side effects.
- Proton therapy is particularly effective for localized cancers, cancers near vital organs, and pediatric cancers.

Traditional Radiation Therapy



- Radiation affects everything in its path so doctors often limit the dose to minimize damage to critical organs.
- X-rays continue to pass through the body after reaching the tumor, affecting the healthy cells beyond it.
- X-ray radiation therapy is often used for cancers that have spread beyond the initial tumor site.
- High-dose, precision X-rays can be delivered through image-guided and intensity-modulated therapies. However, a larger area is exposed to low-dose radiation than with proton therapy.

*****Information Courtesy of Midwest Proton Radiotherapy Institute*****

As a result, normal, healthy tissue receives less exposure to radiation, resulting in fewer treatment complications. Fewer treatment complications enable radiation oncologists to deliver higher doses of radiation to the tumor. This increased dose improves a patient's probability of a successful outcome. The

overall effects lead to the potential for fewer harmful side effects, more direct impact on the tumor, and increased tumor control.

Conditions Treated with Proton Beam Radiation

Recent technological advances have allowed proton therapy to treat a wide range of cancers. Proton therapy is most effective for localized tumors or cancers that are located near a vital organ. Some conditions currently treated with proton beam radiation therapy are as follows:

Benign Tumors
- Acoustic neuroma
- Arteriovenous alformation (AVM)
- Craniopharyngioma
- Pituitary adenoma
- Intracranial meningioma

Ophthalmological Conditions
- Malignant/benign tumors of the orbit
- Ocular (uveal) melanoma

Head and Neck Malignancies
- Nasopharyngeal carcinoma
- Paranasal sinus carcinoma
- Oropharyngeal/parapharyngeal malignancies

Base of Skull Sarcomas
- Chordoma and chondrosarcoma

Spinal Cord and Paraspinal Tumors
- Paraspinal soft tissue malignancies
- Chordoma
- Sarcoma subtypes

Gastrointestinal Malignancies
- Carcinoma of the rectum
- Pancreatic carcinoma
- Hepatocelluar carcinoma

Genitourinary Cancer
- Bladder carcinoma
- Prostate malignancies

Pediatric Malignancies
- Medulloblastoma, craniospinal
- Ependymoma
- Pineal tumors
- Astrocytoma
- Retinoblastoma
- Orbital rhabdomyosarcoma

Lung Cancer
- Early-stage, medically inoperable lung cancer

Currently, protons cannot be used to treat all cancer patients. Proton radiation treatment is meant to control localized disease; therefore, patients with systemic cancers, such as leukemia, and those whose cancers have spread to other sites in the body cannot be cured with protons. However, researchers and physicians are working on developing techniques to use protons to control metastases, using fewer treatments than are required now with conventional radiation treatment.

PROTON THERAPY FACTS

- **Most precise form of radiation treatment available because it radiates primarily the tumor site, leaving surrounding health tissue and organs intact and unharmed.**
- **Minimum to no side effects resulting from treatment.**
- **Highly effective treatment for tumors in the head, brain, neck, lung and prostate.**
- **Loma Linda University Medical Center opened the world's first hospital-based proton treatment facility in 1990.**
- **Treatment protocols being developed to treat breast cancer in the near future, as well as other areas of the body.**
- **Therapy often used in conjunction with other cancer treatment modalities, including traditional X-ray therapy surgery, chemotherapy, seed implants, and immunotherapy.**
- **Treatment time can take from one day to seven weeks depending on affected site.**
- **Proton therapy is covered in the U.S. by Medicare and most insurance providers.**
- **Proton therapy is not considered experimental and it has broad indications. Tumors considered for proton therapy should be localized, require high doses of radiations for control, and be located near sensitive normal tissues.**

About the Author:

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