PENCIL BEAM SCANNING

Proton therapy is a type of radiation treatment that uses proton particles to treat cancer. Due to the Bragg peak phenomenon, proton therapy allows for superior dose distribution as compared with conventional radiation therapy (photon)[1] This enables radiation oncologists to precisely target a tumor with the highest dose possible, while sparing healthy tissue and organs. Because of this, patients experience reduced side effects, improved long-term outcomes, and an enhanced quality of life.[2,3,4]

There are three types of proton-beam delivery methods: passive scattering, uniform scanning, and pencil beam scanning. When identifying treatment options and developing treatment plans, it is important to consider the method of proton-beam delivery. Pencil beam is the most modern form of delivering proton beams to patients.

WHAT IS PENCIL BEAM SCANNING?

Pencil beam scanning (PBS) is the most precise form of proton therapy. Using an electronically guided scanning system and magnets, PBS delivers proton therapy treatment via a proton beam that is just millimeters wide. With PBS, beam position and depth are able to be controlled, allowing for highly precise deposition of radiation to be delivered in all three dimensions of the tumor.

ADVANTAGES OF PENCIL BEAM SCANNING

BEAM MODIFICATION

PBS does not require the use of patient-specific or field-specific devices (apertures, compensators) in the delivery of proton therapy treatment. This eliminates treatment delays, reduces treatment time, reduces costs, increases flexibility in treatment delivery, and reduces patient exposure to secondary radiation produced when the beam hits a device.

Delivery of proton therapy treatment with passive scattering or uniform scanning requires the use of patient-specific devices to conform the dose to the treatment volume. Unique devices are needed for each patient and for each treatment beam, because the shape of the tumor is unique to each patient, and because body composition can change during treatment, it is often necessary to create new devices over the course of treatment.

Whether the manufacturing of these devices occurs in-house or is outsourced, treatment cannot begin until the devices are in hand. When evaluating proton beam delivery methods, both treatment delays and costs related to device manufacture must be considered.

It is also important to consider the increase in treatment time and secondary radiation due to the use of the devices. As discussed above, it is necessary to use a different device for the delivery of each treatment beam. Switching devices for the treatment of each tumor field takes time, thereby increasing treatment time. Further, the secondary radiation that results increases the integral radiation dose to the patient. Neutrons are generated when a proton beam hits a device. Radiation that does not directly target the tumor is undesirable, especially when treating pediatric patients, as they have an increased risk of developing neutron-induced secondary cancers later in life.[5]

Finally, because the devices are exposed to radiation during treatment, and become radioactive, they need to be stored for a period of time before they can be disposed of. The cost and space associated with storing these devices, and their environmental impact, must be considered when evaluating the delivery methods of proton therapy treatment.

DOSE SCULPTING AND EFFICIENCY

PBS delivers superior dose sculpting and higher beam efficiencies than other methods of proton beam delivery. This reduces unwanted side effects, improves long-term outcomes for patients, and improves the patient's quality of life.[6]

The method of proton beam delivery employed by PBS allows for a sharper Bragg peak than passive scattering – allowing for the treatment of deep-seated tumors. One of the biggest advantages of PBS is that each proton beam can be controlled in terms of position and intensity. The delivery of highly inhomogeneous treatment volumes is unique to PBS and allows for superior dose sculpting.[7]

Additionally, PBS can achieve beam efficiencies of close to 100%, while the beam efficiencies of passive scattering are typically between 3% and 15%.[8]

Due to the superior dose sculpting and high beam efficiencies, PBS delivers lower doses of radiation to critical structures and healthy tissue than other proton beam delivery methods. This reduces side effects and improves long-term outcomes for patients, and improves the patient's quality of life.[9,10]

WHO CAN BENEFIT FROM PENCIL BEAM SCANNING?

Pediatric patients and patients with irregularly shaped tumors or tumors that are in close proximity to organs, critical structures, or significant normal tissue will benefit most from PBS.

The clinical efficacy of PBS has been shown in research on:

- Breast cancer
- Gynecological cancer
- Cancers of the head, neck, and skull base
- Liver cancer
- Lung cancer
- Lymphoma
- Pediatric cancers
- Prostate cancer
- Rectal cancer
- Spinal cord cancer

THE RADIANCE 330® PROTON THERAPY SYSTEM

We have designed the Radiance 330® to be compact and customizable. This allows us to install Radiance 330® in locations where other systems cannot be installed.

Combined with the industry's fastest return on investment and the precision of pencil beam scanning and the power of integrated imaging, Radiance 330® is the choice for proton therapy technology.

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ProTom International is a leading device manufacturer of proton therapy technology.

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Collaboration fuels innovation. We have long-standing partnerships with the Massachusetts Institute of Technology, Bates Research and Engineering Center, Massachusetts General Hospital.

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