Editorial

Proton therapy: a cutting-edge cancer treatment

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Proton therapy is a cutting-edge cancer treatment which is an advanced form of radiation therapy for cancer patients.[1-3] Traditional radiotherapy uses high energy beams of photons or light to kill cancer cells. Proton therapy employs a beam of positively charged particles-protons accelerated to speeds of 60% of light speed and energies up to 250 million electron volts. Using magnets these high energy protons are precisely targeted to specific site of tumor in the body where the energy is delivered to destroy the tumor cells. This technique allows for precise targeting for cancerous cells while minimizing damage to surrounding healthy tissues. In traditional radiation therapy energy is released along the entire path of the beam, in proton therapy, the energy is deposited at specific points.[1] Proton therapy, thus delivers higher radiation energy directly to tumor site sparing nearby tissues and organs from high doses of radiation exposure.

How proton therapy works

Protons are produced from negatively charged H atoms (H-). Negative H atoms are formed by process occurring in the plasma volume and plasma surface by the mechanism of dissociative electron attachment to rho-vibrationally excited hydrogen molecules.[4] Proton therapy uses special equipment's such as synchrotron and cyclotron to accelerate protons to high energies. These protons are directed with precision to the tumor site. Unlike traditional X-ray radiation, which releases energy along its entire path, protons deposit the majority of their energy at a specific point known as the Bragg peak.[1] This unique property enables proton therapy to deliver higher radiation doses directly to the tumor while sparing nearby tissues and organs from excessive exposure.

Advantages of proton therapy

1. **Precision and reduced side effects:** The ability to localize radiation at the Bragg peak reduces damage to surrounding healthy tissues and organs. This is particularly beneficial for treating tumors located near critical structures, such as the brain, spinal cord, or eyes.
2. **Improved outcomes in pediatric cancer:** Children are more susceptible to long-term side effects of radiation, such as growth impairments and secondary cancers. Proton therapy's precision minimizes these risks, making it a preferred choice for pediatric oncology (5).
3. **Lower risk of secondary cancers:** The reduced exposure of healthy tissue to radiation decreases the likelihood of secondary cancers developing years after treatment.

Applications of proton therapy

Proton therapy has shown promise in treating a variety of cancers,[4-6] including:

- **Brain and spinal tumors:** Due to its precision, it's particularly effective for treating gliomas and chordomas.
- **Pediatric cancers:** Commonly used for medulloblastomas and rhabdomyosarcomas.
- **Head and neck cancers:** Helps protect sensitive structures like the optic nerves and salivary glands.
- **Prostate glands:** Offers high success rates with minimal side effects compared to conventional radiation therapy.

Limitations and challenges

Despite its advantages, proton therapy is not without limitations

1. **High cost:** Building and maintaining proton therapy centers require substantial investment, often limiting access to this treatment.
2. **Limited availability:** As of now, only a few specialized centers worldwide offer proton therapy, leading to long waiting times for patients.
3. **Not suitable for all cancers:** Certain cancers, such as widespread metastatic disease, may not benefit significantly from proton therapy compared to traditional treatments.

Future directions

Advances in technology aim to make proton therapy more accessible and cost-effective.[6] Compact proton therapy systems and advancements in imaging techniques are expected to reduce infrastructure costs and improve treatment precision. Additionally, ongoing research is investigating its efficiency in combination with immunotherapy and chemotherapy, potentially broadening its application.

Conclusion

Proton therapy represents a significant advancement in cancer treatment, offering minimal side effects and unparalleled precision. Currently proton therapy is limited by cost and availability, ongoing technological advancements will make it more widespread with reduced cost. Proton therapy has immense potential to redefine the landscape of oncology, providing hope to countless patients worldwide.

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Conflicts of interest

The author has no conflicts of interest to declare.

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