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Advances in Radiotherapy : Proton Therapy

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Radiation (X-ray) was first utilized for cancer therapy in 1896. For 100 years, radiation therapy followed two general guidelines for improved therapy: greater tumor conformity and higher biological effectiveness. The greater conformity can be achieved by using Intensity Modulated Radiotherapy (IMRT). The use of protons also counts in the context of better target conformity because protons provide an inverse dose profile and the sharp dose fall-off at the end of the range.

Rationale for Proton Beam Therapy

One half of all cancer patients receive radiation therapy for either curative or palliative therapy during the course of disease. Radiation therapy offers cure rates of 50−60% of patients who present with localized disease. This cure rate can be increased with more radiation dose to the cancer since most of cancers have a dose-response relationship. However, radiation side effects from the damage of normal tissue surrounding cancer prevent more radiation to cancer. Photons (X-rays) cannot be delivered to the maximum amount to control tumor without causing serious side effects in some of cancer patients. Photon, a type of electromagnetic waves, exerts different physical properties from proton (particle). Photons deliver maximum radiation to the normal tissue in front of the target (tumor) and cannot stop once it has passed through target resulting in radiation exposure to normal tissue behind the target as well. Unlike photons, protons deliver maximum radiation to the target and stop right after they have passed the target resulting in no radiation exposure to normal tissue behind the target. Compared with photon, proton therapy, therefore, allows more radiation dose to the target while limiting the dose to the surrounding normal tissues. As a result, proton therapy can improve tumor control while minimizing side effects.

Some might have a wrong concept that proton therapy is only useful for some rare tumors such as choroidal melanomas, brain tumors, or chordomas, etc. since it has been used for these tumors for many years. As you may notice, all these tumors are superficial in location. In the past, most of accelerators available in the physics laboratories produced low energy proton beams, which were only suitable for treating these superficial tumors. At the present time, technology has been advanced; which not only allow us to make accelerator producing higher energy proton beams in compact size, but also allow us to make it less expensive. There are numerous data from treating deep seated tumor, such as lung cancers, hepatomas, prostate cancers, etc, supporting these tumors are as responsive as those superficial tumors. In addition, because there are fewer side effects, patients generally experience a better quality of life after proton therapy than after photon therapy. Proton therapy is no longer an experimental treatment but uses well-known radiobiological and physical principles, and has been approved by Medicare and many medical insurance companies in USA.

Research using Proton Beam Therapy

Our research interests are to quantify the clinical gains offered by this new treatment modality using protons through well-designed, prospective clinical trials. The primary goals of clinical research are as follows:

1) To test the hypothesis that, in tumors with sub-optimal local control with photon therapy, the superior dose localization of proton therapy will allow increased tumor doses that will result in increased local control while maintaining treatment related morbidity and quality of life.

2) To test the hypothesis that, in tumors with satisfactory local control, but with high treatment related morbidity with photon therapy, the superior dose localization of proton therapy will allow to decrease treatment related morbidity and to improve quality of life while maintaining current local control.

In addition, radiation biology and physics research using proton beams will be also performed.