Proton Therapy

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In the recent years, about 60 percent of patients affected by a solid tumor have undergone radiation therapy for their disease.

Radiation treatment is based on the use of photons (x-rays); when x-rays are directed to a tumor, because they have no charge, they transfer their energy at an evenly decreasing rate to the healthy tissues between the surface of the body and the target, as well as to the tissues beyond the tumor, until they exit the body. Proton beams, on the other hand, have a positive charge and deliver most of their energy at a defined depth in an uniform manner in the target, within the so called Bragg Peak region. None or very little energy is left for potential damages beyond the target volume. Protons have a unique advantage over photons because of the superior ability of confining the high-dose region to the target while minimizing the dose to the surrounding normal tissues.

Charged particle beams of accelerated protons accomplish the function of an almost ideal external radiation source for cancer therapy. This property allows irradiating tumor targets located next to critical structures with high doses avoiding or reducing important side effects in organ at risk (OARs). In total, the overall area exposed with standard radiation is much larger than that exposed with proton therapy. In clinical terms, that means depositing a high radiation dose in the tumor and a low dose outside.

These characteristics can translate in an improved therapeutic ratio and have been exploited in treating several tumors in adults and children with very promising results. After the first proposal of their clinical utility in the seminal article by Wilson (Wilson 1947), protons have been extensively studied in the 70's and 80's mainly in physical research laboratories where the accelerators were located. Only recently, on the basis of positive clinical results, there is a growing interest in hospital-based clinical facilities. Beginning with the first patient treated in the fifties more than 50.000 patients have now been treated worldwide. The first proton accelerator dedicated to medicine opened at Loma Linda University in California in 1990. Public interest in proton therapy has grown substantially since the FDA approved it in USA in 2001. Today, a total of seven proton therapy centers are treating patients in the United States and eight in Japan and numerous others are under construction or in the planning phase.

Proton beams are generated by cyclotrons or synchrotrons that are huge, expensive machines, but several companies are working on smaller, less-expensive models that may soon make proton therapy available for many more patients.

The treatment is being used most often in children with many cancer types, as well as in adults who have small, well-defined tumors in organs such as the prostate, base of skull, head, neck, bladder, lungs, or the spine. There is no published evidence to indicate that proton therapy is detrimental to patients. On the contrary, it has also to be pointed out that there is a lack of published randomized controlled trials to show that proton therapy works better than standard radiation therapy. We have to consider that there are numerous

practical and ethical barriers to conducting a randomized controlled study with proton therapy: proton therapy is a rare resource and most of the people coming for proton therapy to dedicated centers would not accept being randomized in a clinical trial. For these reasons, comparing the outcomes of proton therapy with previously published studies of x-ray therapy should be sufficient