

Proton Therapy for Prostate Cancer

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Proton therapy is a type of external beam radiation therapy which can deliver radiation dose to the tumor. Proton therapy is considered as one of the most advanced technologies for the treatment of the cancer. One of the main reasons to use proton therapy for cancer treatment is due to its ability to produce excellent dose distribution because protons have finite range and sharp distal fall-off at the end of proton beam path. [1] Literature review shows that the proton therapy has been extensively used for the prostate cancer treatment. Although surgery is also an option for prostate cancer, researchers have found the use of proton therapy as an alternative option to treat the prostate cancer. [2] In the recent years, the use of this advanced technology for cancer treatment continues to increase. However, there is also an ongoing debate on the cost of proton beam therapy [2].

A number of researchers have investigated the dosimetric benefits of proton therapy over conventional photon therapy. [3-11] Dosimetric results demonstrate that proton therapy and photon therapy are both equally good, and in some cases, proton therapy can be better, especially while sparing the bladder and rectum. This also depends on the choice of number of beams, beam delivery techniques, and treatment planning systems. [3-11]. It has been noted that, in the high-dose regions, photon therapy could be better in sparing of the bladder, whereas in the low-dose regions, proton therapy is superior in sparing of both rectum and bladder [3]. One of the recent studies [4] compared the proton therapy versus photon therapy in the form of volumetric modulated radiation therapy (VMAT) for high-risk prostate cancer, and the study showed comparable target doses, but proton therapy was better at sparing the rectum and bladder, especially in the low- and medium-dose regions, but results in a higher femoral head dose. Zhang *et al.* [5] identified the proton advantage for normal tissues in the low-dose region. Vargas *et al.* [6] showed that proton therapy reduced the dose to the critical structures when compared to the photon therapy.

Traditionally, prostate cancer case is treated using two parallel opposed lateral proton beams. Few studies have reported the use of non-lateral fields for the prostate cancer treatment. For example, Trofimov *et al.* [3] and Tang *et al.* [10] have shown that angled lateral proton beam can reduce rectal dose. Another recent study by Rana *et al.* [11] investigated the use of proton therapy for prostate cases with a metallic hip prosthesis. This study [11] demonstrated that the combination of lateral and

oblique fields in proton therapy could potentially provide dosimetric advantage over the VMAT for prostate cancer involving a metallic hip prosthesis. Despite the dosimetric studies showing superiority of proton therapy over photon therapy, there is less data available to show how these benefits are applicable to the clinical outcome.

Currently, there are several research trials [12] in progress for proton therapy of prostate cancer, and clinical results from these trials are expected to provide more information on the real clinical benefits of use of proton therapy for the prostate cancer. Another thing to note is that proton therapy has not reached its full potential yet, and proton therapy continues to evolve. For example, new proton therapy centers are in the process of implementing pencil beam scanning technology [13,14], which is considered to be more advanced technology compared to uniform scanning and double scattering. The clinical benefit of pencil beam scanning proton therapy for prostate cancer needs to be further studied.

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