The Science of Proton Therapy

Both conventional photon (X-ray) radiation therapy and proton therapy kill cancer by interfering with the DNA of cancer cells, preventing them from dividing and growing. The difference is that proton therapy can be precisely targeted to the tumor, allowing patients to receive higher, more effective doses, and greatly reducing damage to healthy tissue near the tumor. Research shows proton therapy causes fewer side effects than traditional radiation therapy, diminishes the chances of secondary tumors and improves quality of life for patients.¹,²

X-rays are electronic waves that penetrate tissue, gradually losing energy as they move along. To penetrate deeply enough in the body to reach most tumors, higher doses of X-ray therapy must be used. The result is that the highest radiation dose occurs shortly after entering the body meaning that much of the radiation reaches the healthy tissue in front of the tumor. Once the radiation reaches the tumor, it continues to pass through the body, affecting healthy tissue behind the tumor. That can cause a variety of side effects, some of which can seriously affect quality of life and health.

Protons are large particles that can be manipulated to release their energy. The more energy, the deeper the protons can penetrate into the body. Physicians can calculate the precise amount of proton energy needed to release the radiation exactly at the tumor site. The peak of this radiation dose (called the Bragg Peak) is designed to conform to the back of the tumor, and immediately after that point, the radiation dose falls to zero. Less of the radiation reaches the healthy tissue in front of the tumor, and virtually none of it reaches the healthy tissue behind the tumor. That results in much less damage to healthy tissue and, therefore, fewer side effects. It also means that a higher dose often can be delivered, leading to more effective treatment.
With X-ray radiation therapy (yellow line), the radiation dose peaks soon after entering the body and often, long before reaching the tumor, gradually decreases. Healthy tissue surrounding the tumor receives much of the dose. With proton therapy (red and green lines), treatment can conform more closely to the tumor, so that less radiation reaches tissue in front of the tumor than is the case for X-ray therapy, and almost none reaches the healthy tissue behind the tumor.

There are far fewer side effects with proton therapy both in the short and long term. For instance, more than half of men who receive X-ray therapy for prostate cancer experience short-term side effects such as diarrhea and painful urination, compared with virtually no side effects reported by patients who undergo proton therapy. While 15 percent of people who have X-ray therapy for head and neck cancer become blind, only 2 percent who undergo proton therapy experience that side effect. And 28.5 percent of children who have X-ray therapy to treat tumors in the brain or spine experience a 10-point IQ drop, compared to less than 2 percent of those who undergo proton therapy. Proton therapy also lessens the probability of secondary tumors later in life, a significant problem for children who are cancer survivors.3


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