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Applications of Proton Therapy for Breast Cancer

Narrator:

Welcome to **Medical Breakthroughs** from Penn Medicine, Advancing Medicine Through Precision Diagnostics and Novel Therapies.

Dr. Caudle:

Proton therapy is currently used to treat brain, spinal, and prostate cancers, as well as many other tumors. Another potentially significant application is the treatment of breast cancer. You're listening to ReachMD and I'm your host, Dr. Jennifer Caudle, and with me today is Dr. Gary Freedman, Associate Professor of Radiation Oncology at the Hospital of the University of Pennsylvania. Dr. Freedman, welcome to the program.

Dr. Freedman:

Thank you very much for having me.

Dr. Caudle:

So, let's first discuss the role of radiation in the treatment of women with breast cancer. Can you tell us a little bit about radiation and how it's used in breast cancer with women?

Dr. Freedman:

Radiation is used for many women with the diagnosis of breast cancer, for both early and more advanced stages of breast cancer. For women who have more early stage breast cancer and they're treated by a lumpectomy or a breast-conserving surgery, radiation is commonly used to the breast in order to reduce the risk of recurrence. Lumpectomy and radiation have been proven, with long-term followup, to equal and match the cure rates of a mastectomy. Now, for women who either choose a mastectomy or because their breast cancer is more advanced require a mastectomy, radiation sometimes plays a role in treating their breast cancer as well. So, radiation can be used after mastectomy in many women for different indications.

Dr. Caudle:

Okay, great. And how about, let's move onto the use of photon-beam radiation for breast cancer. Can you talk about this a little bit?

Dr. Freedman:

For decades when we talked about radiation therapy to treat cancer, we've always been talking about primarily photon radiation. Since the early days of radiation, even back in the 1960s, 1970s, the early equipment used photon-beam radiation. Photon-beam radiation is an x-ray. Think of it as a high-energy form of x-ray, the same as you would have for a CAT scan, or a chest x-ray, or a mammogram, that's all x-ray radiation. The radiation we use to treat breast cancer is just a much higher energy than what you would get from a diagnostic x-ray. Photon radiation then has been the standard for decades, but the modern equipment has really improved technologically, so that the machines that we use today to give

photon radiation can't even be compared to what was used 20, 30 years ago. That radiation today can be very carefully designed and targeted to the area that we want to treat, in this case the breast, and we've made large strides in the last 10 to 20 years and able, with computer modeling, to make the dose even more accurately get to where we want it to go and also to try and avoid the normal tissue as much as we can.

Dr. Caudle:

That's very interesting and it sounds like that's maybe one of the newer advances. Is that correct, with the photon-beam radiation, that we're able to sort of target a little bit better?

Dr. Freedman:

Photon-beam radiation has improved dramatically since the early days of the 1960s to 1980s. The question that is arising is, has photon beam improved so much that are we at a point that there's no additional room for improvement? And that's where we begin talking about proton-beam radiation. So, photon-beam radiation, as we said, is a form of x-ray. Proton-beam radiation is a heavy charged particle, part of the basic structure of the atom. Proton-beam radiation has different properties than a photon beam. Proton-beam radiation can be more carefully calibrated so that it can enter into the patient's body and, at a certain depth, be designed to sort of run out of gas and just stop. Where x-ray radiation is more deeply penetrating and can't be made to stop short at a patient, then tends to pass through the body to the other side. So, while photon-beam radiation has improved dramatically and our ability to shape and target has improved, protons still have certain advantages in the way that they're able to be shaped and targeted.

Dr. Caudle:

Interesting. Now are there any particular technical challenges with the proton-beam radiation and, if so, maybe what are they and how are these overcome?

Dr. Freedman:

Proton-beam radiation has challenges that are typical of a new technology that really has only been around for a few years. Photon-beam radiation that's given today with a modern linear accelerator is like looking at the iPad 5. You know, it's had 40 years of technical improvements and software improvements so that the machines today are very reliable. Proton-beam radiation has only been around for a few years and while it is extremely advanced, it continues to be much more expensive, it requires a large team of physics and engineering, requires a much greater amount of space, and there are still a lot of challenges that are being worked on literally each year that it's been out to try and improve the software and improve the hardware to improve its efficiency.

Dr. Caudle:

Interesting. Well, if you're just tuning in, you're listening to Medical Breakthroughs from Penn Medicine on ReachMD. I'm your host, Dr. Jennifer Caudle, and I'm speaking with Dr. Gary Freedman, Associate Professor of Radiation Oncology at the Hospital of the University of Pennsylvania, and we are discussing radiation treatments for breast cancer. So, Dr. Freedman, can you talk about how these different technologies are being used at your institution?

Dr. Freedman:

Currently, while we do have state-of-the-art photon-radiation therapy, there are still many cases where we feel that there can be improvement in the way the radiation is given to the patient. There are women who have left-sided breast cancer, for example. There are women who have more challenging shape to their chest. There are women who have breast reconstruction. There are women who have a need to target lymph nodes near the breast that also happen to be very close to the heart. All these are cases where it's felt that proton-beam radiation has a potential to further reduce the amount of dose that's given to the heart and the lung while we're treating the breast. So, protons are offering that potential to reduce dose to those structures. As I keep stressing though, it is a potential. Protons have been used at our center only for the past 3 years. So, we don't have necessarily the long-term experience to be able to show that, in fact, there are fewer lung complications or that there are fewer heart complications. At the present time, that's a very, very big question that insurers and patients and physicians want to have answered. Are the improvements possible with protons based upon different

radiation planning studies? Are the theoretical improvements in dose to those organs? Are the special properties of protons going to actually translate on a practical daily basis to a patient having fewer side effects? I think that's the real question of the day for protons. Can protons demonstrate that they are worth the cost and the greater technical challenge than photons?

Dr. Caudle:

That's interesting. Can you talk a little bit, before we talk about some of the current research and studies that are happening, you're talking about sort of the potential for side effects and some of the information that we just don't know. Can you speak then about the effectiveness then with protons and how you feel about how effective they are?

Dr. Freedman:

Right now, and this is true for breast cancer and also other cancers, we don't really know if protons have any greater effectiveness at treating breast cancer than a photon beam. That we consider that both are ionizing forms of radiation that cause DNA injury to cancer cells and cause them then to die off. And we don't really know if protons would be any better or have some unforeseen advantage in killing cancer cells. So, currently in our clinical practice, we turn to protons when it seems that the dose that we are going to give to a patient's lung or heart is higher than we would normally like to accept with photons. So, I will have a patient come to me and we will begin designing their radiation therapy with photons and in many cases I will, during the phase of treatment before they even begin, when in the computer world, if you will, in virtual reality, we can use computer modeling to say, "This photon plan is really unacceptable, because in this particular case, it's really giving much greater dose to the heart than we would normally accept." It's those cases that I then discuss protons with the patient, and I discuss with them the very promising results we have with protons and that, in their particular case, we may be able to reduce the dose to the heart or to the lung in that particular woman.

Dr. Caudle:

Interesting. Well, can you now speak a little bit about any current studies that you might be involved with regarding proton therapy?

Dr. Freedman:

We have a large national study that is headed out of the University of Pennsylvania by Dr. Justin Bekelman. This is going to be a national study that is being run under a radiation therapy comparative effectiveness consortium which means that it's a group of national centers, there are 22 academic centers and community practice centers that are going to be enrolling patients into this clinical trial. The clinical trial is simply a head-to-head comparison of photon-beam radiation, which many consider to be the current standard, with proton-beam radiation, which is going to be tested. It's meant to be a very practical study. It's meant to have a very broad eligibility, and to treat women with breast cancer who may benefit from proton radiation because of their special circumstances of, let's say, either left-sided breast cancer, or if they might be at greater risk of dose to the heart. The study is unique in that it's major endpoints are going to be the quality of life of the patient and also, very specifically, will we see differences in heart disease when we follow patients for the next 5 to 10 years? In the past, photon-beam radiation has been associated with an increased risk of heart disease, particularly when treating women with left-sided breast cancer. So, it's going to be very important to see if protons live up to what is hoped, that they're better ability to be shaped and targeted, it is hoped that that is going to translate into actually seeing fewer cardiac problems in women over the next 5 to 10 years.

Dr. Caudle:

Before we finish our discussion, do you have any final thoughts you would like to discuss with our listeners, or any thoughts you would like our listeners to know about proton therapy with breast cancer?

Dr. Freedman:

I would say that proton radiation therapy has real promise in not only treating breast cancer, but matching or improving the results that we currently have with photon radiation, but I do want to stress that high-quality photon radiation is still available today and I don't want women to think that if protons aren't available near them, then somehow they're not getting state-of-

the-art treatment. Proton radiation, in our current center, is not being used for all patients or for even most patients. We are currently being very selective and offering protons only to women where we've tried a plan for photons and we clearly see that it's not going to be acceptable and that we know that proton-beam radiation will reduce that dose to the heart and lung.

But this study is really talking about broadening the application of protons. What we need to do in the next 5 years is to try to demonstrate, should protons really be more broadly expanded all over the country and made available to the average woman with breast cancer all over the United States, or even the world, or should protons only be limited to a select number of academic practices, or that would be available as a tertiary referral center for more challenging cases that would cover certain regions? This is an opportunity right now to try and decide if the nation should be investing the kind of resources to really expand proton to a more wide national audience, or keep it on a more regional basis with just a few Centers of Excellence that are there so that patients can be referred from the community only if there are special challenging problems with their photon plan. And that's really what this study is all about.

Dr. Caudle:

Well, Dr. Freedman, I thank you very much for being with us today and sharing your information about the innovations of proton therapy in breast cancer at the University of Pennsylvania. I'm your host, Dr. Jennifer Caudle, and I appreciate everyone for listening today.

Narrator:

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