

**ROBERT WERMERS:** So we see a lot of complex patients with primary hyperparathyroidism at the Mayo Clinic in Rochester. And specifically, we see patients who have had parathyroid surgery. But after surgery, they have persistent disease. They have persistent hypercalcemia.

When you see a patient with persistent or recurrent primary hyperparathyroidism where the disease either comes back or doesn't ever get cured by their parathyroid surgery, then there's a whole series of things that the endocrinologist would think about, including multiple parathyroid gland disease or an ectopic parathyroid adenoma where the disease lies outside of the usual location.

Typically, we would start with reimaging those patients with the usual methods, which would be a parathyroid scan or neck ultrasound, or a combination of both. And then if those fail to localize the parathyroid disease, we would sometimes consider doing a multiphasic or 4D parathyroid CT. Those patients who we do the usual imaging in and we have no localization of their parathyroid disease are good candidates for the PET Choline, C11 PET Choline CT.

**STEPHEN CASSIVI:** So it's been a tremendous improvement on what we had before, which was much more scattered image, almost not unlike the Shroud of Turin, the old imaging. Now, we have a much more focused 3D image of where the actual gland is. And we can get a much more specific plan for the minimally invasive surgery.

**GEOFFREY JOHNSON:** The most common indication for a Choline PET CT or a PET MRI scan is recurrent prostate cancer. However, we came to realize that this scan could be used for other indications. And we found in patients that, if they had a parathyroid adenoma, we also saw that on the Choline PET scan. We noticed it serendipitously on the scans and suggested the diagnosis. And then found out that it was true and ended up curing patients from their parathyroid disease when they had received the PET scan for a different reason.

**STEPHEN CASSIVI:** The introduction of Choline PET has certainly helped us to better localize these ectopic or otherwise placed parathyroid glands, abnormally placed parathyroid glands, in the chest. What Choline PET does is it allows us to really focus and find

the exact spot so that we can then focus our surgery to a very tiny area of the chest. We can focus down on a small area of the chest, go in, disrupt very little tissue, take out the offending gland, and return the patient to a normal level of parathyroid hormone and overall normal level of calcium to remove their symptoms.

**ROBERT WERMERS:** We've actually been successful in localizing parathyroid adenomas in those patients. And it can be either in a usual location or in an ectopic location, such as the mediastinum or an area that's not typically imaged in some of the other procedures, especially neck ultrasound.

**GEOFFREY JOHNSON:** So we initially published that idea many years ago. But since then, we and many other places have confirmed that Choline PET imaging is not only a great way to find parathyroid adenomas hiding in the body, but maybe the best way to find the disease hiding in the body.

**ROBERT WERMERS:** Experience has been positive in general with finding disease that we couldn't find with any other localization techniques.

**STEPHEN CASSIVI:** The future role of this modality, I believe, is in going one step further in localizing and being able to demonstrate the localization of the abnormally placed parathyroid gland by allowing us then to use the choline, if possible. This is not yet achieved, but if possible, when you're within the chest to confirm the placement or the location of the gland by localizing the actual choline uptake.

**ROBERT WERMERS:** Endocrinologists should think about doing this type of imaging when they've been unsuccessful in localizing disease, especially in a patient who has persistent or recurrent primary hyperparathyroidism.