CASE REPORT

# Radiation Therapy Post Prostatectomy Using Axumin Imaging for Target Definition

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**Abstract**

Radiation therapy delivered post-prostatectomy can provide durable disease-free clinical outcomes. There remains debate as to whether the radiation should be applied to patients with high risk features post-surgery or deferred until there is biomarker evidence of clinical recurrence. Prior to the development of advanced-technology metabolic and anatomic imaging, the radiation therapy treatment fields were applied based on historical models of patterns of failure including the former capsule region, undersurface of the bladder, and the bladder urethral anastomosis. Although outcomes of therapy were good, the choice of the target was not image directed. Modern imaging has provided an advantage for targeting as radiation oncologists can be more secure of high-risk areas and in turn titrate dose to regions deemed of intermediate and low risk. In this paper we describe strategies for application of modern Axumin imaging for patient care with radiation therapy post prostatectomy.

**Key words:** Advanced-technology radiation therapy, prostate cancer, Axumin imaging, clinical outcome

## 1. Introduction

Surgery for prostate cancer has evolved over the past three decades with improved and durable clinical outcomes. Modern techniques combined with skilled practitioners have improved nerve and genitourinary function.[1-3] However, despite improved tools for modern care, patients with prostate cancer remain at risk for recurrence including patients who may not have at risk features on pathology.[4-6]

While radiation therapy is successful either as adjuvant or definitive therapy, despite years of clinical experience, the volume of therapy required for care remains less well defined. Although most radiation oncologists target at a minimum the former capsule area, the urethral anastomosis, and under-surface of the bladder. A smaller cohort of radiation oncologists treats a broader field of para prostatic tissue and a minority of radiation oncologists will intentionally treat expanded nodal targets including the prostate bed. These targets were presumed areas of disease however these targets could not be easily validated, and each received a similar radiation therapy dose potentially increasing both acute/late toxicity to areas which have undergone surgical resection. This was effective however there was room for improvement as often the choice of targets often could not be better defined and there is potential that additional tissue volumes could be titrated.[7-10]

Modern imaging has become integral to the application of advanced technology radiation therapy. Targets are now image validated daily, but of more importance is that diagnostic images can be fused into planning images and areas of therapy can be better defined and optimized. This has had significant influence on defining treatment targets in all disease areas. Magnetic resonance images have improved targeting for intact prostate radiation therapy including improved definition of the fat plane posterior to the prostate.

Positron Emission Tomography (PET) functional imaging can detect disease not seen on conventional imaging. Radiation oncology teams use PET-CT scans for precision targeting of treatment volumes. The radioisotope, anti-1-amino-3-(18F)-fluorocyclobuate-1-carboxylic ($^{18}$F-FACBC), also known as fluciclovine or Axumin, is used to identify prostate cancer, especially recurrent disease. Axumin can detect disease with low PSA levels and the exact location of the disease after definitive treatment.[11,12]

For post-prostatectomy therapy, the recent Food and Drug Administration approval of the Axumin tracer PET has given radiation oncologists the opportunity to adjust and titrate the volume of therapy receiving high dose and optimize the definition and separation of high-risk areas to treat as well as areas of intermediate and low risk.[13-20] Radiation oncologists can now feel more secure applying high dose therapy to targets with a defined purpose.

In this paper we review three patients whose treatment plans were adjusted and optimized by the application of Axumin imaging prior to developing a treatment plan for radiation therapy.

## 2. Description

### Patient One

The patient is currently 60-year-old (yo) male. He presented in 2014 with PSA of 4.31 ng/ml. Twelve (12) core biopsies were performed and 5 of 6 from the right revealed Gleason grade 8 (4+4) adenocarcinoma involving 80% of 2 cores with perineural invasion. One core on the left revealed Gleason 7 (4+3) adenocarcinoma and 3 cored from the left revealed Gleason grade 6 (3+3) adenocarcinoma. After conversation with all involved services, the patient underwent robotic-assisted prostatectomy. The final pathology revealed 0 extracapsular spread of disease and PSA obtained on a post-operative basis was not detectable.

In late 2020, PSA had increased to 0.49 with asymmetry noted on rectal examination including a small nodule biased to the right which had harbored Gleason 8 disease with perineural invasion. Imaging was obtained including an Axumin scan which confirmed uptake in the region appreciated on clinical exam with a 9 mm focus of disease (Figure 1).

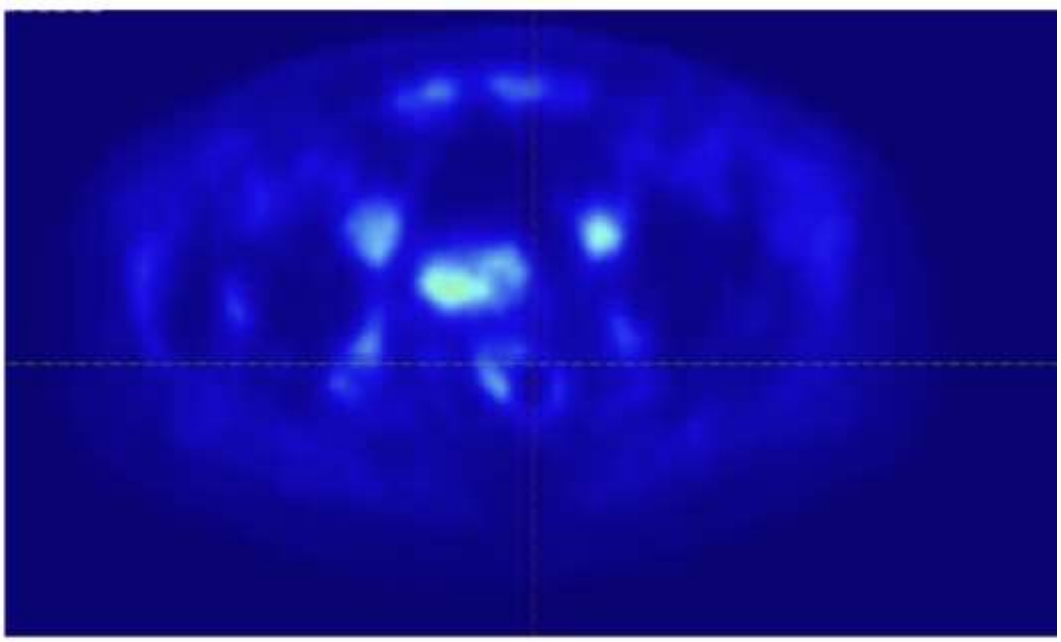

**Figure 1.** Patient One - Axumin scan confirming uptake appreciated on clinical exam.

The patient was treated with definitive radiation therapy. To the prostate bed target and low pelvic lymph nodes, 5000 cGy was delivered, 6000 cGy to the traditional prostate bed volume, and 7400 cGy to the image guided abnormality defined on Axumin (Figure 2). The patient tolerated therapy well with no clinical acute or late toxicity issues and favorable PSA reduction.

 

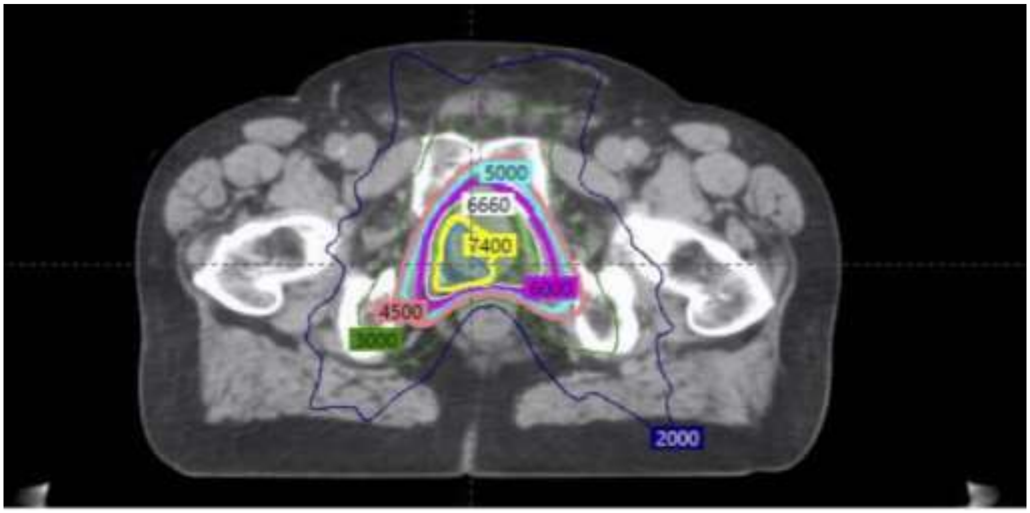


**Figure 2.** Patient One - 5000 cGy was delivered to the prostate bed target and low pelvic lymph nodes, 6000 cGy to the traditional prostate bed volume, and 7400 cGy to the image guided abnormality defined on Axumin.

**Patient Two**

The patient is currently a 77 yo male who underwent robot-assisted prostatectomy in 2013 for Gleason grade 7 disease (4+3) involving less than 5% of the prostate gland on the right. In spite of the modest volume of disease in the gland, there was perineural invasion. The specimen revealed no additional high-risk features and the lymph nodes were negative. Post-operative PSA was undetectable, however by late 2020 had increased to 0.25 ng/ml and pre consult PSA had increased to 0.45 ng/ml. Axumin scan was obtained and demonstrated increased uptake with a 5 mm nodule at the region of the right superior capsule in the prostate bed abutting the bladder (Figure 3).

**Figure 3.** Patient Two - Axumin scan demonstrated increased uptake with a 5 mm nodule at the region of the right superior capsule in the prostate bed abutting the bladder.

 

The patient was treated with definitive radiation therapy to 5000 cGy to the prostate bed and low pelvic lymph nodes, 6000 cGy to the prostate bed and 7000 cGy to the lesion defined on Axumin (Figure 4). The patient tolerated therapy well with favorable post therapy PSA.

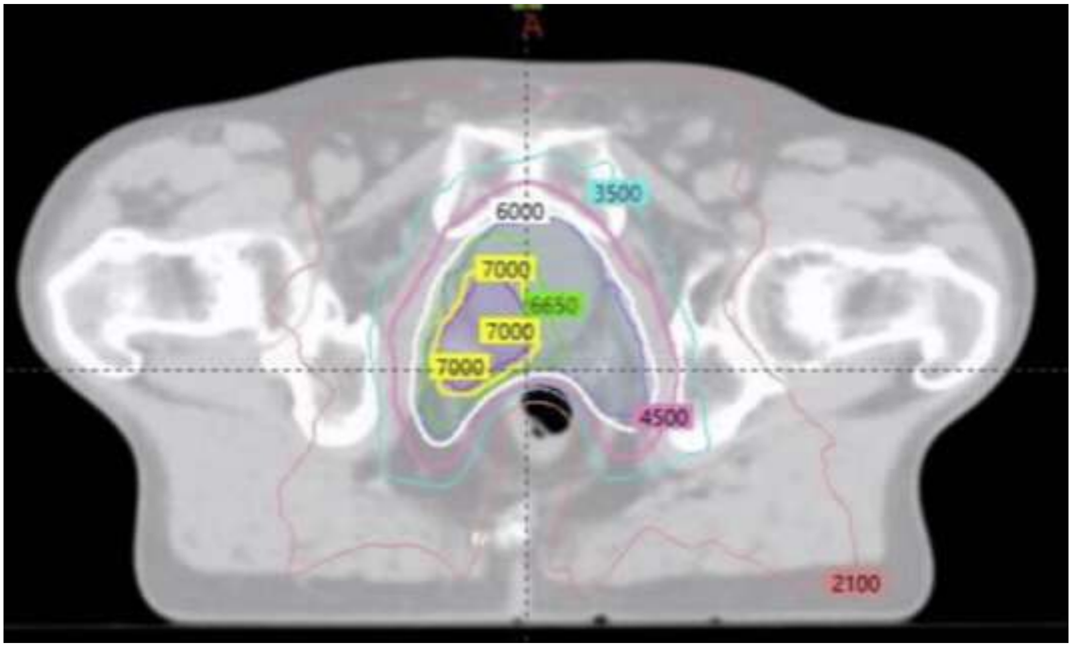


**Figure 4.** Patient Two - The patient was treated with definitive radiation therapy to 5000 cGy to the prostate bed and low pelvic lymph nodes, 6000 cGy to the prostate bed and 7000 cGy to the lesion as defined on Axumin.

**Patient Three**

The patient is currently an 82 yo male who at the age of 62 underwent an open prostatectomy at an outside hospital. Details of surgery revealed tumor in more than 50% of the gland with Gleason 7 (4+3) disease and a positive posterior margin on the right close to the midline. The patient reported than he also received androgen deprivation therapy prior to surgery at that time, type uncertain. He was seen by urology colleagues in late 2020 for PSA of 5.27. The patient began Casodex and Lupron and an Axumin study was obtained early into hormonal therapy. The study revealed uptake in the posterior prostate bed anterior to the rectal wall (clinically palpable) with subtle symmetric uptake in the inguinal regions (Figure 5).

 

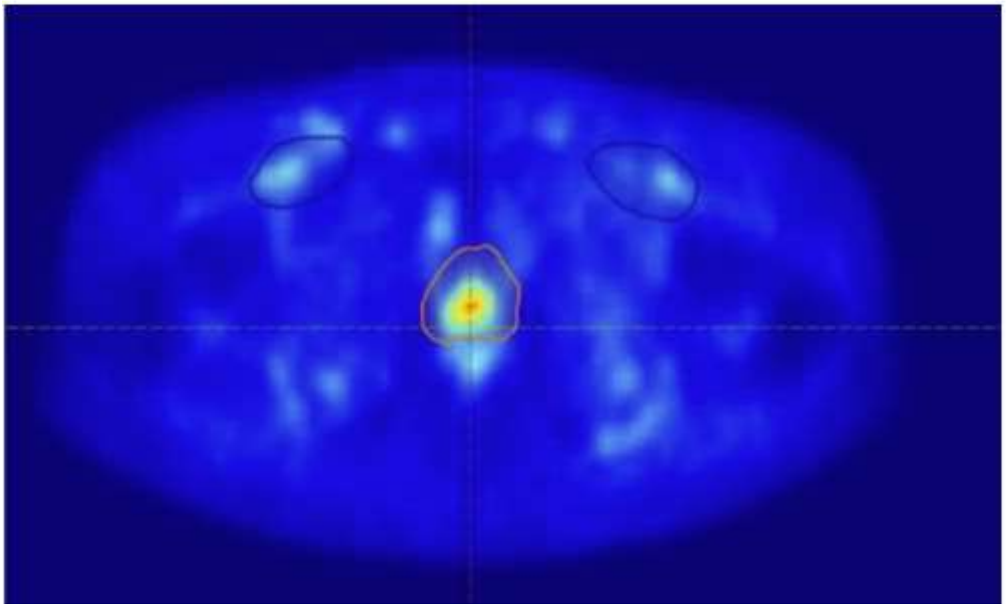

**Figure 5.** Patient Three – Axumin study revealed uptake in the posterior prostate bed anterior to the rectal wall (clinically palpable) with subtle symmetric uptake in the inguinal regions.

The uptake anterior to the rectal wall was at the region of the positive margin. Radiation therapy was administered with definitive intent. Although trace uptake in the inguinal region is seen with routine on metabolic imaging, the decision was made to include these areas and define them as targets of intermediate risk (Figure 6) secondary to the fact the uptake was seen on early hormonal therapy.

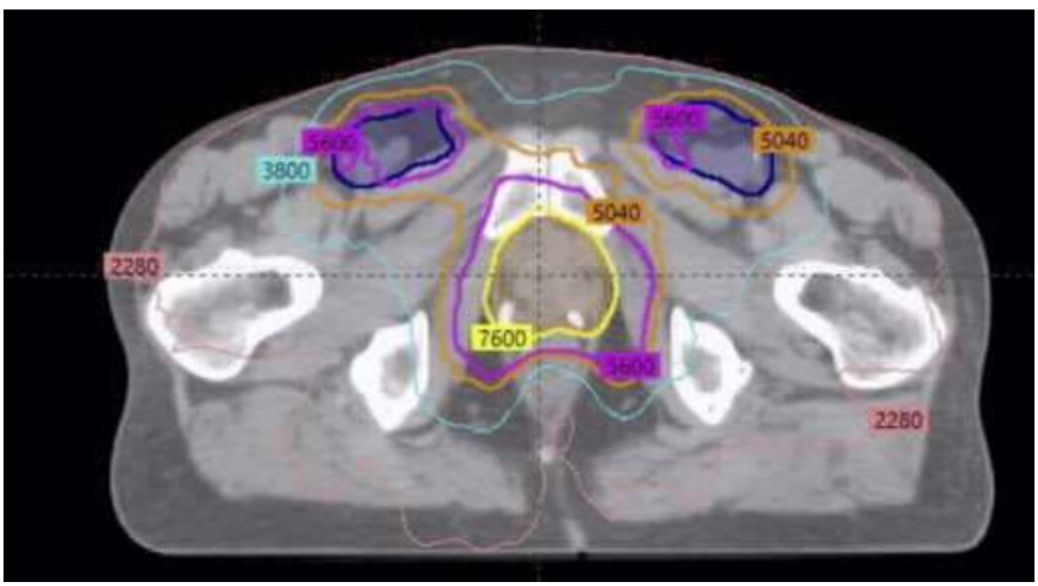


**Figure 6.** Patient Three – Axial radiation therapy treatment geometry in the inguinal region for targets of intermediate risk.

 

Axial radiation therapy treatment geometry is seen in Figure 6. The patient received 5000 cGy to low pelvic lymph nodes and prostate bed, 6000 cGy to the prostate bed/inguinal lymph nodes and 7600 cGy to the primary site of recurrence in the posterior prostate bed abutting the anterior rectal wall. The patient tolerated treatment without incident with favorable PSA response.

## 3. Discussion

Radiation therapy administered to post prostatectomy patients can be delivered in an effective manner. To date, target definition has been applied by radiation oncologists based on operative findings and thoughtful applications of targets at risk.[6-10] Off protocol, radiation oncologists have varied interpretations of what should be the target in these patients. Areas at risk include the anastomosis, urethra, former prostate capsule, lymph node targets, and para prostatic tissue. These are applied by radiation oncologists in a non-uniform manner and on review, at times the choice of the target and dose to volume is at the discretion of the treating radiation oncologist.

Imaging has the potential of providing a more common ground strategy to the application of radiation therapy to this patient population.[11-20] Although it remains to be better established in clinical trials that metabolic imaging accurately defines all sites of disease, Axumin provides confidence that we can identify the areas that require high dose therapy. This permits radiation oncologists to be more selective defining areas of potential intermediate and low risk of recurrence and apply dose per their clinical judgment. This is clinically important as tissues that have been resected are at greater risk of injury when radiation therapy is applied. If metabolic imaging provides an opportunity to limit dose to resected tissue, potentially improving patient outcome.

There is an opportunity to also treat tissue that might not have been anticipated as well. Figure 7 is an example of recurrent disease in the right external iliac region after primary surgery. This area can be treated individually with stereotactic techniques or dose painted as part of primary management.

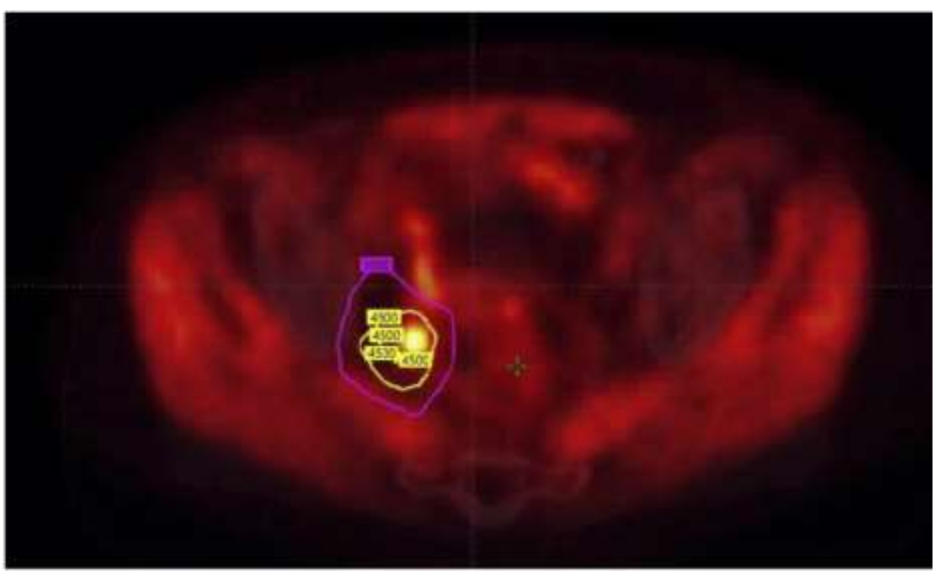

**Figure 7.** Recurrent disease in the right external iliac region seen after primary surgery that can be treated individually with stereotactic techniques or dose painted.

 

Radiation therapy technology has significantly improved over the patient two decades including intensity modulation and image guidance. However, improvements in patient care and target definition will continue to improve with continued integration of advanced technology imaging into radiation therapy planning. When targets are accurate, care and outcomes will improve.

## 4. Conclusion

Axumin studies have provided improvement in target definition for radiation therapy and have given us an opportunity to increase dose to selective targets and titrate does to targets that are of intermediate concern. This has the opportunity to both improve tumor control and decrease risk to normal tissue.

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