

Benefits of the CyberKnife® for Prostate Treatment

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Introduction

Radiation therapy is a type of cancer treatment that uses high- energy rays to kill cancer cells. There are many cancers that can be treated with radiation, but a common type is prostate cancer. Prostate cancer is the most common type of cancer diagnosed in men. The types of radiation therapy used to treat prostate cancer are external beam radiation, brachytherapy, and radiopharmaceuticals. The most common machine used for radiation treatment is the linear accelerator. Most patients are treated using the linear accelerator but a select few can be treated using the CyberKnife®. The CyberKnife® is a machine that uses external beam radiation that can treat prostate cancer in qualified patients. Some of the benefits of the CyberKnife® treatment could be fewer side effects, less radiation to normal tissue and increased accuracy of treatment area compared to traditional radiation treatment. The patients who do not qualify for the CyberKnife® treatment will be treated using the linear accelerator which will be just as effective.

Prostate Cancer

Signs/symptoms

- With early prostate cancer there are no symptoms, but advanced prostate cancer may include symptoms such as:
 - Problems urinating
 - Blood in the urine
 - Pain in the hips, back, or chest
 - Weakness or numbness in the legs or feet

How is it diagnosed?

- Most early prostate cancer is found through screening
 - Blood Test; PSA (Prostate Specific Antigen)
 - Physical Exam; Digital Rectal Exam
- Biopsy
 - Gleason Score assigned if biopsy results are positive
 - If the cancer resembles normal prostate tissue, a grade of 1 is assigned
 - If the cancer looks very abnormal, it is given a grade of 5
 - Grades 2 through 4 have features in between these extremes

How it it treated?

- Radiation Therapy
 - External Beam Radiation Therapy (IMRT or SBRT)
 - Linear Accelerator or CyberKnife®
 - Brachytherapy (internal radiation)
 - Radiopharmaceuticals (medicines containing radiation that are injected into the body)
- Surgery, Hormone Therapy and/or Chemotherapy



Figure 1: Linear Accelerator
1. Monitor
2. Couch/Table
3. Gantry

Treatment Preparation

- Initial consult
 - Nurse obtains patient history
 - The radiation oncologist discusses the treatment options, treatment plan, and prognosis (Radiation Therapist, Personal Communication, 2023)
- CT Simulation (figure 2)
 - Patient is set up in the exact position that is used for treatment
 - Tattoos are placed on patient (Physicist, Personal Communication, 2023)

Figure 2: CT Scanner



- Treatment plan by dosimetrist (figure 4)
 - Dosimetry refers to the measurement of radiation dose and it shows how the radiation is distributed throughout the patient's body
 - Dosimetrist uses the treatment parameters established during CT simulation. To determine radiation dosage appropriate to the prostate tumor (Long et al., 2019, p.445)

Treatment Equipment

CyberKnife® (figure 5)

- Best for treating small tumors
- External photon radiation beam on a robotic arm continuously tracks the tumor using fiducial markers to track the tumor (OncoLink, n.d.)
 - Fiducial markers (figure 3) are small metal (typically gold) spheres, coils or cylinders about the size of a grain of rice that are placed in or near a tumor to help guide treatment (Memorial Sloan Kettering Cancer Center, 1970)
- Radiation beams are delivered from thousands of angles and directions simultaneously (Long et al., 2019, p.451)
- Delivers stereotactic radiation therapy or “radiosurgery” (SRS) and stereotactic body radiation therapy (SBRT) (OncoLink, n.d.)
 - SBRT is a technologically sophisticated form of radiotherapy, which holds significant potential to treat high risk prostate cancer (Correa & Loblaw, 2022)

Linear Accelerator

- Most common machine used for larger treatment areas
- External beam radiation producing high- energy photons or electrons (Long et al., 2019, p.439)
- The machine rotates during the treatment process without the ability to move in thousands of directions
- Does not track tumor (Physicist, Personal Communication, 2023)

What is the criteria for patients to be treated on the CyberKnife®?

Qualifications

- The treatment area must be small
 - Early-stage disease
 - Localized disease (confined to prostate)
 - A prostate volume size of less than 80-100cm (OncoLink, n.d.)

Disqualifications

- Bigger treatment area
 - Lymph node, Seminal Vesicles, Bone (Physicist, Personal Communication, 2023)

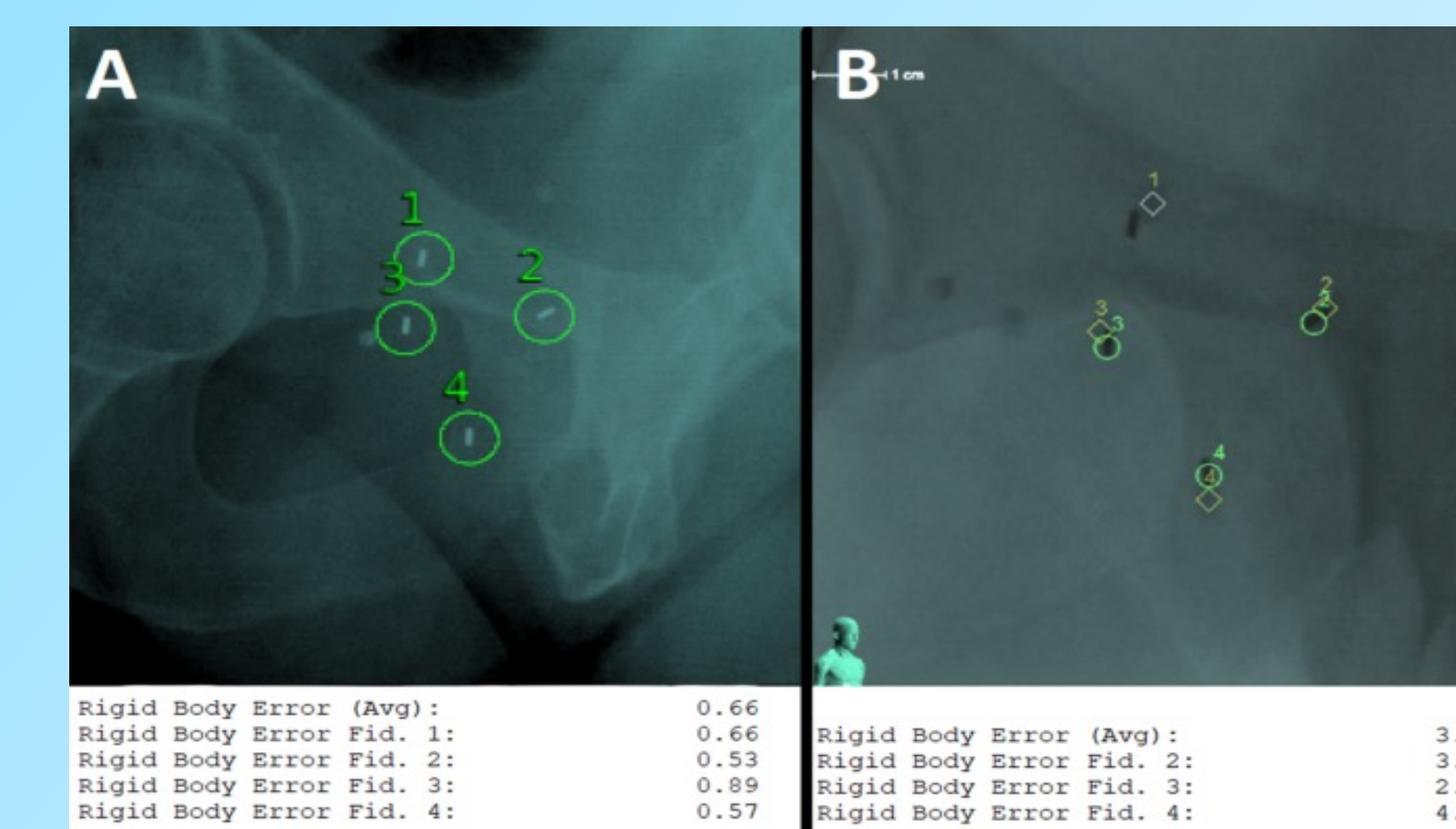


Figure 3: Fiducials

Patient Prep and Treatment Set- up

Patient prep for CyberKnife® :

- The patient should come for treatment with an empty rectum and a full bladder
 - Some patients take laxatives to clear their rectums before treatment then begin to fill their bladder
 - This is important so the prostate is always in the same position
 - An empty rectum is important, so it is not in the treatment field
 - A full bladder pushes the intestines out of the treatment area (Nasser, 2021)

Treatment Set-up

- Immobilization devices will be used for patients treated on the CyberKnife®
- Fiducials are tracked during treatment to ensure accuracy (Radiation Therapists, Personal Communication, 2023)

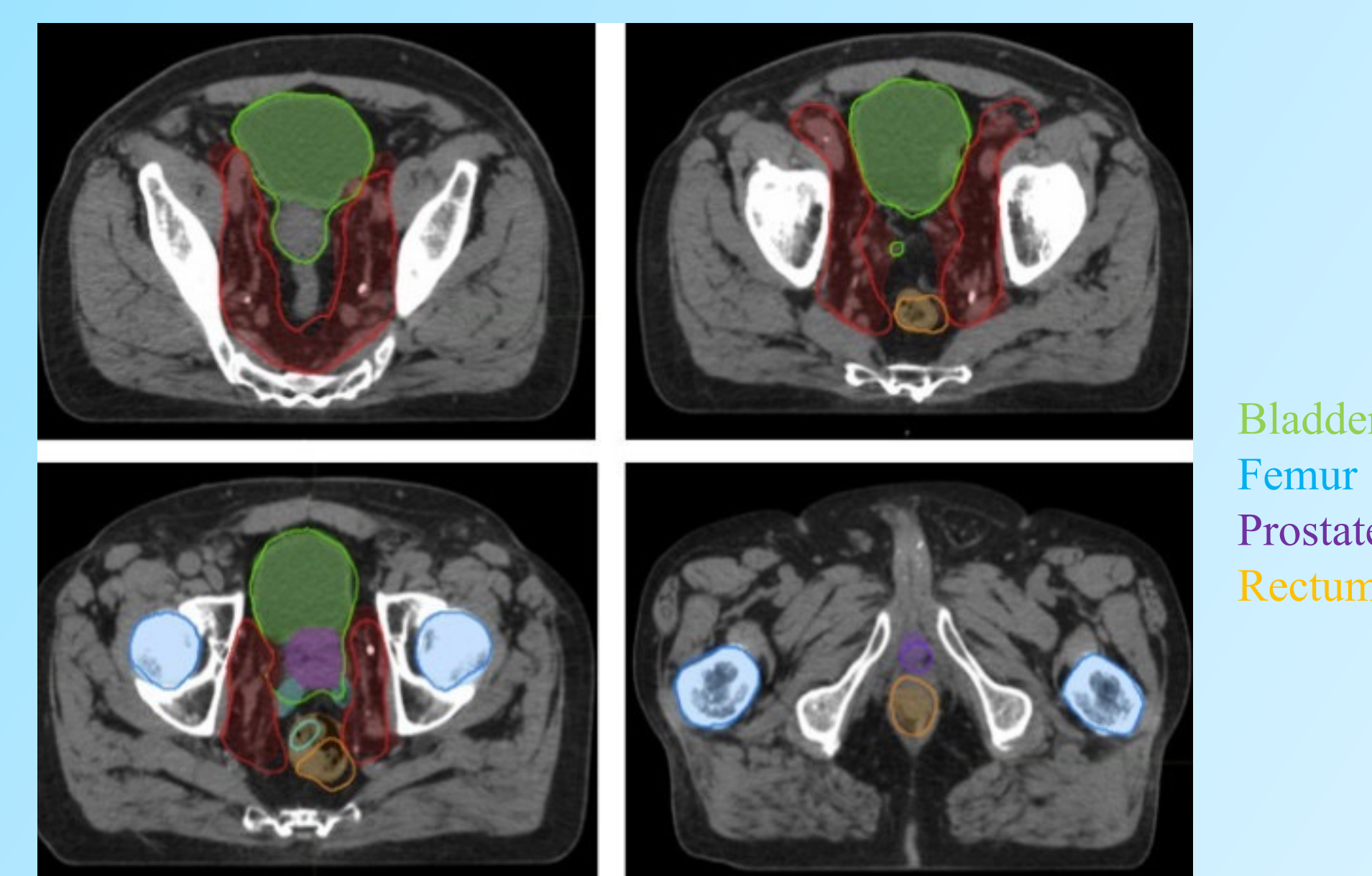


Figure 4: Prostate Treatment Plan

Benefits

Benefits of the CyberKnife®

- Is the only system that adjusts to patient motion
- Intra-fraction motion management
 - Compensates for involuntary motion (Physicist, Personal Communication, 2023)
- “Small beams enter in various angles to conform tightly to the target” (Long et al., 2019, p.451)
 - Spare nearby critical structures (Long et al., 2019, p.451)
 - Improves symptoms

Outcome

- When prostate cancer is localized radiation therapy is considered curative
- “Five-year survival data for prostate cancer is nearly 100% for localized and regional disease and decreases to 31% for disease that has spread distantly” (Leaver, 2021)

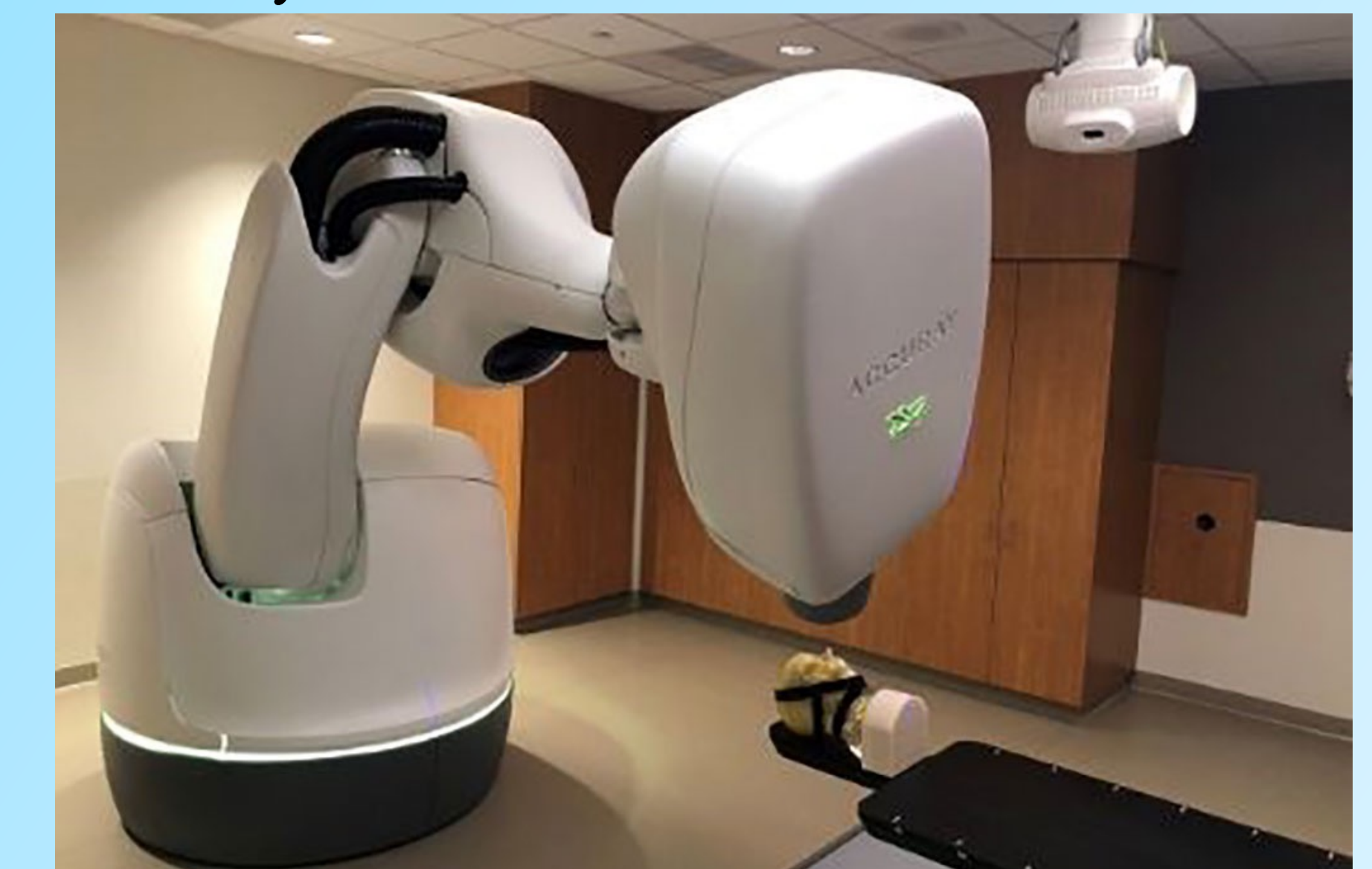


Figure 5: CyberKnife®

Conclusion

There are several different ways to treat prostate cancer. Radiation therapy is a common treatment for cancer, that uses high-energy rays to kill the cancer cells. There are many steps before radiation therapy treatment can begin. Some of the steps include an initial consult with the radiation oncologist and a CT simulation. Radiation Therapy patients can be either treated using the linear accelerator or CyberKnife®. There are qualifications a patient's disease must meet to be treated using the CyberKnife®. The qualifications include early- stage disease that is localized to the prostate and is a volume less than 80-100cm. The CyberKnife® has many benefit for the treatment of prostate cancer. It is the only system that adjusts to patient motion; it uses intra-fraction motion management; and it spares nearby critical structures by employing small beams that focus on the target area directed in multiple angles. By sparing the nearby structures, the symptoms the patients may experience could be improved. The CyberKnife® also tracks fiducial motion to ensure the radiation dose is precise. Prostate cancer can be cured when the disease is localized and treated with radiation therapy. There is a five- year survival rate of nearly a 100% for localized prostate cancer.