

LINAC SCRIPT

Narrator: *LINAC radiosurgery is a technique used in the treatment of cancer. Basically, it is a way of performing surgery on a patient using high-energy X-Rays instead of cutting them open to remove a tumour. Jamie volunteered to run through a LINAC machine to show us how it works.*

Jamie: I'm Jamie, and I'm going to go through a LINAC radiosurgery procedure. This involves really high doses of radiation so they won't actually be running the machine on me...but we will get an idea of what's involved. I had heard of radiation *therapy* as a cancer treatment, but I wasn't really sure what *radiosurgery* was... so I checked in at the desk and waited until they were ready to show me how this all works.

I was checked in by a receptionist, who would take a patient's information. Patient planning is really important in LINAC surgery...every patient gets a perfect custom-designed treatment plan.

Once they were ready for me, they brought me in to get changed. While I get changed, you can learn about what the LINAC machine does.

N: *LINAC stands for linear accelerator, which is the technology in the machine that can create high-energy X-Rays that will destroy the tumour. You may have heard of radiation therapy...that involves repeated lower dose X-Ray treatments to stop cancer cells from reproducing. What we're seeing here is radiosurgery. It's based on the same principles, but it uses higher doses of radiation to actually destroy the cancer cells inside the body. They can target a tumour with an X-Ray beam to blast it away. Doing this without destroying surrounding healthy cells is what makes LINAC surgery so powerful, but is also what makes it complicated and delicate.*

Before a patient shows up for radiosurgery, doctors, physicists and therapists will have already developed a detailed plan for the surgery. Patients would have a CT scan to find and map out their tumour. Next, highly trained medical physicists use the CT scans to determine how to program the LINAC machine...they need to figure out how to get the proper dose of radiation to the tumour while minimizing the dose to surrounding and sensitive tissues. Here you see a medical physicist looking at CT scans of the patient...he can even get a CT scan view with the tumour highlighted in red, the spinal cord in yellow and the kidneys in green and blue. Each patient's treatment plan is carefully put together and checked several times. The treatment plan is designed to maximize the radiation dose to the tumour and minimize the dose to surrounding tissue. We'll check out the machine to see how the surgery is done.

J: Once I was changed, they brought me into the treatment area to see the LINAC machine...it was like walking through a maze. They explained that the maze and its walls are made of special concrete that can protect the operators on the other side from the X-Rays used in the surgery.

I laid down on what they call the 'couch'. The blue mattress is kind of like a big beanbag...it would have been formed around a patient when they went for their CT scan. When patients come for their surgery, they get back into the form so they are in exactly the same position. They can also run CT scans and X-Rays on this machine to make sure that patients are positioned properly

So here I am moving up toward this giant machine. You can kind of look up into the machine as you are laying there...during surgery, X-Ray beams will fire out of this opening.

N: *The most important part of radiosurgery is getting the proper dose of radiation to the tumour. This is done by shaping the beam and rotating the machine around the patient. X-Rays are produced in the 'gantry', which can rotate around the patient. Inside the gantry is the linear accelerator...microwaves accelerate electrons to speeds near the speed of light and then they smash into a heavy metal target. This is kind of like making X-Rays in a normal X-Ray machine, but the accelerator adds much more energy. This collision creates X-Rays of incredibly high energy...enough to destroy tissue.*

As the beam leaves the gantry, it is shaped by the collimator... obviously, tumours are not perfect shapes...they come in many irregular shapes and sizes. If we look into the collimator, you can see one hundred and sixty 'fingers' that can shape the beam as it comes out. Here, we are just looking at a visible light pattern so you can get an idea of how this works.

J: This room even had all these green laser lights shining around it. The therapist told me that they mark something called the 'isocentre'...this is where all the X-ray beams will cross...they want the tumour to be right at this point. Once they had everything in position, the therapist went out to the control room and started moving the machine around me. It's a little scary to think that this machine creates radiation so powerful that it can destroy cells inside of a person!

N: *The machine moves around the patient and will fire X-ray beams at positions and shapes determined by the treatment plan. The highest radiation point is around the isocentre where the beams overlap. The least radiation is where there is no overlap. A physicist calculates and plans all of this so that the tumour lies in the isocentre and receives the highest dose...the shape can be narrowed down to within less than one millimetre of the target! It's like painting a radiation dose on the tumour. This is all planned out on a screen that looks like this...kind of like a contour map...each coloured area shows a different dosage of radiation: low at the skin and high at the tumour where there will be lots of overlap. We can also see the position of the beams for the treatment.*

J: It's a little weird being all alone in this room with such a powerful machine, even though the therapist could see me and talk to me the whole time. When they were done moving the machine, the therapist came back in to get me out of the machine. He told me that for a real patient, the treatment would have been painless, but they have to be aware of side effects that may occur later, depending on the radiation dose experienced by tissues surrounding the tumour. Patients would have follow-up treatments to complete the surgery and they will undergo monitoring and scanning to determine the success of the procedure.

N: *Relying on detailed, personalized treatment plans and a deep understanding of medical physics, LINAC radiosurgery is at the cutting edge of cancer treatment. Combining technology, computing power and the talents of medical physics and radiation specialists, LINAC gives us the power to target and destroy tumours without cutting a person open.*