

**TRILOGY STEREOTACTIC RADIATION THERAPY FOR BRAIN TUMORS
HARTFORD HOSPITAL
HARTFORD, CONNECTICUT
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ANNOUNCER: Welcome to Hartford Hospital. Over the next hour you'll see Trilogy Stereotactic Radiation Therapy for brain tumors. As an alternative to surgical removal of tumors, the Trilogy system delivers higher doses of targeted radiation to smaller areas with more precision. It allows doctors to customize the treatment plan for each patient. The system works by damaging the cells in the tumor while leaving the surrounding tissue unharmed. In some cases, it causes complete disappearance of the tumor, while in other cases it may prevent further growth of the tumor. This exciting new treatment was available first in Connecticut at Hartford Hospital and offers new hope to patients with certain forms of cancer. OR-Live makes it easy for you to learn more. Just click on the "request information" button on your webcast screen and open the door to informed medical care. Now let's join the doctors.

00:01:17

ANDREW SALNER, MD: Hello, and welcome. We're coming to you live from Hartford Hospital in Hartford, Connecticut. Today we will be treating a patient's brain tumor using Trilogy Stereotactic Radiation Therapy. I'm Dr. Andrew Salner, Director of Radiation Oncology and Director of the Helen and Harry Gray Cancer Center here at Hartford Hospital and host for today's program. I'm joined on my right by my distinguished neurosurgical colleague, Dr. Charles Poletti. I'm also joined by Dr. Susan Kim, a radiation oncologist here, and by Doug Boccuzzi, our chief medical physicist, who are in the BrainLAB system where we plan each treatment. And finally, in the treatment room we're joined by Blanche Jackson and Elaine Blancher. We'll join Dr. Kim and Doug for a demonstration of the treatment planning in just a moment, but before we do I have a few housekeeping items. First, we will be answering email questions during the webcast. To send us your questions now, just click the MDirectAccess button on your screen. We welcome all your questions and will try and answer all of them. Second, an archive of this program will be posted later on this website if you would like to watch the webcast again or share it with a friend, colleague, or family member. Finally, CME is available to medical professionals for participating in this program. To Receive CME credit, click the CME button at the conclusion of the webcast. Today we're going to be talking about acoustic neuroma and the role of stereotactic radiotherapy. Acoustic neuroma is a benign, slow-growing, well-encapsulated tumor arising from the vestibular portion of the eighth cranial nerve. Acoustic neuromas expand the internal acoustic meatus and grow toward the cerebellopontine angle. Acoustic neuromas are relatively rare. They occur in 1 in 100,000 per year, and in the United States we'll see about 2,280 new cases this year. Acoustic neuromas account for about 8% of all brain tumors and usually occur between the ages of 30 and 60. There's a female to male ratio of 3:2, and 95% of these tumors are unilateral. Unilateral progressive hearing loss is by far the most common symptom for acoustic neuroma and present in greater than 90% of patients. Tinnitus also occurs in 70% of patients, vertigo in 67%. About 10% of patients will have facial nerve palsy or dysfunction, and a small percentage will have trigeminal numbness, facial numbness, from the effect on the fifth cranial nerve. The diagnostic workup for

acoustic neuroma includes audiogram, CT scan of the brain, MRI scan of the brain, electronystagmography, and brainstem auditory evoke response testing. Here's an MRI scan of two patients with acoustic neuromas. The screen on the left shows an enhancing acoustic neuroma on a coronal reconstruction, and you see the enhancing lesion adjacent to the brainstem. And the scan on the right shows a small intracanalicular lesion in a transverse section. There are several management options for acoustic neuroma, and the first of which is observation. A study from the Mayo Clinic showed no growth of acoustic neuroma in as many as 70% of patients who are followed over a mean four-year time period. Certainly if there's tumor growth rate at one year, that's a strong predictor that treatment is needed. Dr. Poletti, a comment on observation in some patients who have slow-growing or non-growing tumors?

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CHARLES E. POLETTI, MD: Yes, I think merely the fact that you see a tumor on the MRI does not mean it's growing. In fact, a person can even lose hearing, you can follow them for five years, but just the fact that the tumor's there does not mean it's growing.

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ANDREW SALNER, MD: Okay. The treatment options, if treatment is warranted, include microsurgery; stereotactic radiosurgery, or SRS, and that's when a single fraction of radiation is given; or stereotactic radiotherapy, or SRT, and that's when multiple fractions of stereotactic treatment are given. Charles, you want to tell us a little bit about surgical approach?

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CHARLES E. POLETTI, MD: Yes, the most common approach is a posterior fossa, what we call a retromastoid approach, where the operation is done behind the ear. And you position the patient such that the brain falls away and you can look directly at the tumor and then you either totally remove the tumor or just remove the inside. Sometimes there's an advantage for the ear, nose, and throat people to go through the labyrinth, which is behind the ear. The disadvantage of that is that you automatically lose hearing. And very, very rarely, much less commonly these days, there was an old transtemporal approach.

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ANDREW SALNER, MD: And the results from microsurgery?

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CHARLES E. POLETTI, MD: Again, they vary really tremendously depending on the strategy of the surgeon. In the old days, the surgeons felt that it was incumbent on them to remove the entire tumor, and then the larger the tumor was, the more chance you were to lose the nerves that run on the surface of the tumor, which are the nerve that moves all the muscles to the side of your face, and you look as if you've had Bell's palsy if you lose that, and you lose hearing. Nowadays, and especially radiosurgery, sometimes we can do an excellent subtotal removal, leave a small amount of tumor, and very often that tumor does not grow. If it does grow, we can then treat it with radiosurgery and the person has lost no neural function. So there's been a tremendous advance over the last 10, 20 years.

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ANDREW SALNER, MD: Tell us about -- briefly about the complications of surgery.

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CHARLES E. POLETTI, MD: Well, death is the worst, and surprisingly that does not come from the brain surgeon; that usually comes from -- as in many other forms of surgery, from blood clots in the legs. You can get loss of hearing is very common, even with conservative operations. You can lose -- if you try to take out the tumor too vigorously, you can lose, especially in the larger tumors, you lose the motion of the face. And unfortunately, there's no good plastic repair for that kind of operation. Many tumors you can get even substantial tumors out in the hands of an experienced surgeon. And though you're probably going to lose hearing, you may not lose the motion of the face and you get excellent results.

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ANDREW SALNER, MD: Let's talk a little bit about stereotactic radiosurgery, which is a single fraction delivery. It's highly precise. There's a long experience with stereotactic radiosurgery using the Gamma Knife, which is a series of cobalt beams that are aimed at the tumor for a single fraction, or radiosurgery using a linear accelerator. There's a high likelihood for tumor control with radiosurgery, but there's variable results in terms of hearing preservation when a single radiation dose is given. The morbidity is quite low, however. The basic concepts of stereotactic radiosurgery: it's a single fraction ablative technique where typically a large single dose in the range of 13 gray can be given. And there's a high degree of immobilization needed, so for a single fraction, we place a stereotactic head frame -- the neurosurgeon, I should say, places a stereotactic head frame invasively with fixation pins into the outer layer of the skull. The patient is scanned, and we'll show you that information in a moment, and it's a highly accurate localization. The conformal delivery is highly conformal, so the beams all converge on the target. We use a fiducial localizer box, which we'll show you in a moment, which attaches to the head frame for imaging and to develop a coordinate system from which we can plan and deliver the radiation. We use stereotactic therapies for a host of malignant and benign disorders. The malignant ones may include metastatic cancer to the brain, most commonly breast or lung cancer; for primary brain tumors such as gliomas, astrocytomas, and glioblastomas; and for a series of benign conditions in the brain, including arteriovenous malformations, pituitary adenoma, acoustic neuroma, the case we're presenting today, and meningioma. There are also some functional disorders that can be treated with stereotactic treatment, and one that we've treated fairly commonly is trigeminal neuralgia. And there are others as well. Fractionated stereotactic radiation is utilized when the tumor tends to be a bit larger or when it's adjacent to a structure that could be potentially injured by that single large dose of radiation. And we also now use extracranial stereotactic therapy for lesions in the spine, lung, or liver. And here's a picture of Dr. Poletti applying a stereotactic head frame to a patient. And I gather that that's done the morning of the procedure for an SRS procedure under local anesthesia.

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CHARLES E. POLETTI, MD: Yes, and it's very well tolerated if you give the anesthesia a second. And this lady did very well, and 10 minutes later she went off to her CAT scan and went home that same afternoon and tolerated the whole procedure with really minimal discomfort.

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ANDREW SALNER, MD: This is a picture of the fiducial box, which is placed over the patient's head at the time of the stereotactic scanning and of the stereotactic treatment. And here you see a slide of the patient with the stereotactic frame attached with the localizer in place having a CAT scan done. And here are some of those CT images in place, and you can see that the dots around the head represent the stereotactic localizer establishing a three-dimensional coordinate system from which we'll plan and deliver very precise radiation treatment. This is a picture of the Trilogy linear accelerator, which we'll show you in the flesh in a moment. And the thing to note about the Trilogy as compared with a conventional linear accelerator is that at the top you see the high-energy photon emitting part of the gantry, and on the sides to the right and left of the machine you see a kilovoltage imaging chain, much like you'd find on an x-ray machine in the radiology department, that allows us to take a very rapid digital image of the target area on a daily basis if we need to. That's for image-guided radiation therapy. And here you see a patient in position with the reproducible daily non-invasive fixation device. That's the mask, and we'll show you how we make that in a moment on the patient for fractionated radiation. It fits over their face and it fits under their head, and that allows a position of 1 to 2 millimeters in daily reproducible positioning of the patient. The evolution of this treatment really results from initially the Gamma Knife, where the multiple cobalt beams focus on one sphere in space, and therefore to treat an irregularly shaped tumor, one needed to add multiple spherical targets together to treat conformally. And that of course by definition necessitated

treating a larger volume than you might treat with a very conformal shape. Now, with multileaf collimators, the ability to shape each and every beam conformally, we can treat much more conformal, and that's certainly one of the big advantages of Trilogy. And here you see an example. This is a 10-field non-coplanar beam. The patient's head and target area in orange, the brainstem in green. And you can see multiple blue beams coming in to the target area, avoiding the normal tissues -- the eyes and the optic structures -- and focusing on the target with a very tight radiation distribution of dose around the target. Yet another example are these conformal arcs, where the machine actually rotates around the patient while the treatment is delivered, again focusing a high dose on the target but spreading the dose out so that no normal tissue gets very much dose. It's now my pleasure to introduce Susan Kim and Doug Boccuzzi, who are going to tell us a little bit about our patient and the treatment planning for our patient. Susan and Doug?

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SUSAN Y. KIM, MD: Thank you, Dr. Salner. I'd like to give you a little history about our patient who's going to go through stereotactic radiation therapy today for her very small acoustic neuroma. She presented approximately two years ago. She's a 60-year-old female. She was going through multiple medical problems at that time and did not seek help. About six months ago when she started to develop more problems, she decided to look into her hearing loss. And she also had some tinnitus as well as part of her symptoms. She underwent an audiogram which showed that she did have sensorineural hearing loss on the left, but she had relatively good speech discrimination. This was followed up by an MRI of the brain, which we'll show shortly. This showed a small enhancing tumor, intracanalicular tumor on the left, which measured only about 3 to 4 mm. There was no component going into the brain. The MR image was quite consistent with acoustic neuroma. Acoustic neuromas are generally diagnosed radiographically. It enhances with gadolinium. And she sought many opinions. She sought opinions from Dr. Poletti, from us in the radiation therapy options, as well as four additional opinions from Boston. My recommendation was for fractionated radiation therapy despite having a small tumor. Hearing preservation was very important to her, and I felt that the hearing preservation would be the greatest by using the fractionated regimen. She obtained the four other opinions for Boston, which was observation, microsurgery, radiosurgery, or radiation therapy. So she basically had all options recommended. And eventually she opted for fractionated radiation therapy, and she came to us for radiation planning and start of treatment. We are -- I'd like to show you the MRI scan on this patient, which shows a small intracanalicular tumor on the left, which enhances. This was fused with the CAT scan, and Doug will explain how the fusion and the localization is done as part of planning. Doug?

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DOUGLAS BOCCUZZI, MS, DABR: As Dr. Kim pointed out, we use the MR scan to visualize the tumor. However, the crux of a stereotactic treatment lies in the determination of the stereotactic coordinate system, which not only allows us to calculate the dose that we want to deliver, but it also allows us to very precisely target the treatment area on our Trilogy linear accelerator. In order to do that we need a stereotactic CAT scan to be acquired, which we then volumetrically fuse with the 3D image set from the MR. And by doing that, we're using our BrainLAB system, we are able to visualize the tumor as well as calculate dose and very precisely target the tumor for treatment. Would you like to talk about the contouring?

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SUSAN Y. KIM, MD: The next step would be contouring of the target. It's a very small tumor, and our localization system with the removable mask, we feel that there may be a daily variation of setup of about 1 to 2 mm. So generally a margin is added to the target volume. In addition, we always contour the critical structures, which are optic nerves, eyes, chiasm, and brainstem. It's very important to determine the actual dose delivered to these critical structures when treating any target in the brain. Would you like to talk about the actual planning part of it?

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DOUGLAS BOCCUZZI, MS, DABR: Sure.

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SUSAN Y. KIM, MD: There are different ways of planning, and Doug will demonstrate different types of plans that we have evaluated on this patient and why we chose a certain plan.

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DOUGLAS BOCCUZZI, MS, DABR: Okay. Traditionally LINAC-based radiosurgery involves the use of a circulate collimator, or cone, and an arc-type delivery. An alternative to that, as Dr. Salner had pointed out earlier, is a conformal beam plan where we use a series of non-coplanar conformal beams using a multileaf collimator which at every treatment angle conforms very tightly to the tumor and provides us with a very conformal dose distribution. In this particular case, we did perform a cone and arc-based stereotactic plan as well as a conformal beam plan. We compared and evaluated both of those plans and determined that our conformal beam plan, which consists of 10 non-coplanar static conformal beams using a multileaf collimator, was actually the superior plan. And we used several different evaluation tools to come to that conclusion, one of which is called a dose-volume histogram, and then from the dose-volume histogram we can determine two figures of merit that we use to evaluate the efficacy of the plan. One is a conformality figure of merit that essentially tells us how much normal tissue is involved with the treatment area, and we would like that to be minimized as much as possible and treat only the tumor. And the other tool is a homogeneity figure of merit, which essentially tells us how even the dose is across the target. And at this point I think we'll turn it back over to Dr. Salner.

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ANDREW SALNER, MD: Doug and Susan, thank you very much, and we'll see you again in a minute. Before we go to our tape showing how the mask is made, I'd like to go ahead and read our first email question that's been sent to us: "What is the difference between stereotactic radiation therapy and standard radiation therapy?" And I'll go ahead and answer that. The stereotactic radiation therapy system, as you can see, involves a very precise delivery of radiation utilizing a daily reproducible, accurate immobilization system and coordinate system that is very precise. Standard radiation is also very precise. We frequently immobilize the patient, but the levels of precision and accuracy are not quite as tight, and therefore we use multiple fields with a slightly greater margin of uncertainty with standard radiation than we do with stereotactic radiation, where the margin of uncertainty is much smaller. And that's why we particularly utilize stereotactic radiation in the head, where we can immobilize it and there's not a lot of organ or body motion when we immobilize the head. And now what we'd like to do is go ahead and roll the tape. It shows you how we make the reproducible, non-invasive fixation mask. And here you see aquaplast material, which is a plastic which when it's heated in a water bath will become soft and malleable so that we can shape it around the patient. And the first piece of aquaplast that our staff is removing from the water bath is the posterior immobilization piece. That'll go around the occipital portion of the patient's head, and so it's placed on the immobilization device. The patient's head will rest on it and in a cuff, and it is individually tailored and conformed to the patient's head. So in a moment, after the piece is placed, the patient will lie down, place their head in the cuff, and the aquaplast will shape to the back of their head. And now you see the more rigid fixation device which is being heated, which will shape around the patient's forehead and their upper lip. And here you see that piece that's being shaped over the forehead and the upper lip, which provides a very rigid and reproducible fixation. In addition, we put a separate piece of aquaplast on that goes around the patient's nose as yet another way of ensuring that the patient's head can be immobilized in all degrees of movement. This aquaplast will harden rapidly, and then we'll take a piece of aquaplast and place it over the face. The patient can breathe and see through this. It's not too difficult even for patient who are claustrophobic to tolerate this mask on a daily basis.

And once it's hardened, it's lifted off and it's molded in the appropriate shape for the patient. And we have both an anterior and a posterior mobilization device which is utilized on a daily basis. And here you see in the head holder the immobilization device and the localizer box, which is placed over it, and that's what you'll see in the treatment room in a moment. So localizer box and mask. And now we're ready to bring our patient into the treatment room for her stereotactic radiation therapy treatment. The patient's being escorted into the room by Susan and Doug.

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DOUGLAS BOCCUZZI, MS, DABR: So once we bring the patient into the room, our therapists, Elaine and Blanche, will position her into the BrainLAB mask system -- sorry -- which is a clam shell-type thermoplastic mask [dropped audio]. So the therapist will align the patient comfortably in the mask system, start positioning her into treatment position. And this mask system, as has been pointed out before, has an accuracy or relocatable precision of approximately 2 mm. And as Dr. Kim pointed out before, we actually account for that in the planning process by adding several millimeters of margin onto the intended target.

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SUSAN Y. KIM, MD: This is the top portion of the mask system, and it is quite snug. We want to make sure the patient's in the same position every day. We always ask the patient how they feel within the mask system, whether they do feel it's the same amount of pressure as on the day of planning. That ensures the accurate position of the patient within the mask system. Following the clamping of the upper and the lower shells, the targeting box will be placed.

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DOUGLAS BOCCUZZI, MS, DABR: And I'd just like to point out one thing we're not showing is the high degree of quality assurance that's performed in the background by our medical physics group in order to ensure the precision of this treatment. We routinely conduct tests and irradiate films in order to ensure the accuracy of the placement of the treatment area relative to the machine. This procedure is considered a triangulation procedure where lasers and light field projections from the room and from the machine are used to align the patient to the planned isocenter. The box that is now attached to the patient's head frame has printouts on it that are from the patient's customized treatment plan, which is actually what we are using to stereotactically localize for this targeted treatment on our Trilogy linear accelerator. So we -- go ahead, sorry.

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SUSAN Y. KIM, MD: Once the X, Y, and Z coordinates are set up and the isocenter is set up, the secondary check that we would do on any patient would be to check one of the -- one or two of the conformal beams by using the light fields, which also helps us to localize the patient.

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DOUGLAS BOCCUZZI, MS, DABR: Trilogy has some other special features that are specific to stereotactic radiation -- radiosurgery and radiotherapy, including an electronic couch motion bypass which we enable just prior to treatment. And what this does is it prevents any unintended engagement of the couch motors which would potentially move the patient out of treatment position.

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ANDREW SALNER, MD: Doug, you may also want to comment on the dose rate of the machine, which is something truly unique about Trilogy.

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DOUGLAS BOCCUZZI, MS, DABR: Trilogy actually has a dedicated stereotactic beam, as Dr. Salner indicated, that runs at 1,000 rads per minute at isocenter. And this is about -- this is about three times the normal rate of delivery. And what this does is it allows a very complex and precise treatment such as this one with 10 separate beams coming in from all different angles to be delivered in a very, very short time, and that is important for patient comfort.

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ANDREW SALNER, MD: It is also helpful in terms of being able to accommodate several patients, because in some places a stereotactic treatment can take an hour or two. And in our department, as you will see with Trilogy, a stereotactic treatment can be delivered in 15 or 20 minutes with the same amount of precision and with greater patient comfort.

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SUSAN Y. KIM, MD: We're now setting up one of the conformal beams to be able to check the light field again for localization.

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DOUGLAS BOCCUZZI, MS, DABR: Looks perfect.

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SUSAN Y. KIM, MD: And it's very nice.

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ANDREW SALNER, MD: So that's a visual inspection of the light field from the machine on the localizer box.

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DOUGLAS BOCCUZZI, MS, DABR: And this provides us with an overall check because it shows the conformal leaves from the multileaf collimator as they are projected on the customized printout on the targeting box. It's a good overall check of the positioning, and they'll see leaves are in the correct position. And now we'll reset to position for our image guidance images using a high-quality diagnostic digital images on the Trilogy.

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ANDREW SALNER, MD: One of the email questions while we're getting in place is, "Is your hospital in Houston?" And I'm sorry if it didn't -- if it wasn't clear that we're in Hartford, Connecticut coming to you from Hartford Hospital in downtown Hartford, Connecticut. And another question that's come to me, Why did we choose Trilogy over competing machines such as CyberKnife or Gamma Knife? And the reason is that Trilogy, which is manufactured by Varian Medical Systems in Palo Alto, California, is a much more versatile machine using much newer technology than Gamma Knife or CyberKnife, which are much older technologies. Trilogy has much greater versatility in being able to treat tumors throughout the body. Gamma Knife can only treat tumors of the head. Gamma Knife can only deliver one single radiation treatment. Trilogy, as you heard, can deliver either a single fraction or multiple fractions of radiation.

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DOUGLAS BOCCUZZI, MS, DABR: And larger tumors.

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ANDREW SALNER, MD: And larger tumors. CyberKnife is limited to treatment of the patient from mainly the front side of the patient, whereas as you can see in a few minutes, Trilogy can rotate around the patient completely and treat from all sides of the patient. So it's a much more versatile technology for our patients. And here you see the image guidance, which is truly unique with Trilogy as well, deployed so that we can take a kilovoltage image of the patient -- of the target to make sure on a daily basis that everything is lined up just right. Another question that was asked of us, another email question: "Can stereotactic radiotherapy replace traditional radiotherapy in all cases, even with large tumors?" And I guess I would say for brain tumors, large tumors of the brain like glioblastoma are frequently too large to be encompassed with stereotactic treatment so what we might do it utilize IMRT, intensity modulated radiation therapy, which is a conformal radiation where we do immobilize the head and deliver a certain dose of radiation and then rescan the patient to determine how well the tumor is shrinking, with the idea that we might use stereotactic treatment as a boost as a way of delivering additional radiation to the target area. For small tumors, indeed we may be able to use stereotactic treatment as the definitive treatment, so every patient is quite individualized in terms of the selection of radiation treatment modality. And our staff are, after having set up the onboard imager for the Trilogy -- here you see the

patient with the machine in the lateral position and the onboard imager deployed. Here you see the staff in the console area getting ready to take a kilovoltage image. And the staff is monitoring the patient with video cameras so that they can see the patient and hear the patient. There's also audio equipment in the room so that we can hear and see the patient at all times. And I suspect that one image has already been taken. That's the one from --

00:35:00
DOUGLAS BOCCUZZI, MS, DABR: We've just taken one image. Yep.

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ANDREW SALNER, MD: From the anterior, and now we're rotating the machine around to take an image from the lateral.

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DOUGLAS BOCCUZZI, MS, DABR: So we take two images separated by 90 degrees, and the system is able to calculate whether or not we actually need to make a shift based on the position of the anatomy. And we do this on a daily basis in addition to our localization triangulation technique that we use for localization using the localizer box in order to actually align to bony anatomy. And this is the way that we can make sure that we're properly delivering this very precise treatment on a daily basis.

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ANDREW SALNER, MD: And Susan, do you have a look at the images as they come out?

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SUSAN Y. KIM, MD: Yes. We are actually present for all OBI, onboard imaging -- images, to make sure that the shift is correct. So in this patient -- 0.1 --

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ANDREW SALNER, MD: You're analyzing the data.

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SUSAN Y. KIM, MD: It appears -- the films came out and the shift is only 0.1 cm, 1 mm, shift in one direction. So it's a very, very accurate system.

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ANDREW SALNER, MD: Great. So that shift will be made automatically once the imaging is completed, and then we'll be ready to go ahead and administer the first field.

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DOUGLAS BOCCUZZI, MS, DABR: So one of the nice things about the Trilogy system is that we're able to make the shift remotely from outside the room. The therapists push a motion enable button and the shift is made, and now we know the patient is properly in the treatment position based on the radiographic imaging that we've just done.

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ANDREW SALNER, MD: And now the -- is the machine now ready to be moved to the first? Okay, here you see the onboard imager being moved back into its non-deployed position.

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DOUGLAS BOCCUZZI, MS, DABR: And then we'll get ready for the first actual treatment beam. Now, for safety purposes we -- the therapist will actually go into the room and move the couch to each couch position as per the customized treatment plan in order that we want to avoid any kind of collision of the linear accelerator components.

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SUSAN Y. KIM, MD: She has 10 conformal beams of treatment but 5 couch angles, so that requires about 5 interruptions of her treatment for the therapist to go in to change the table position.

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DOUGLAS BOCCUZZI, MS, DABR: And because of the high dose rate of 1,000 rads per minute that we had mentioned before, the actual beam-on time is quite short.

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ANDREW SALNER, MD: And we might want to just mention that all the rotations in this room -- that is, the couch and the gantry and the collimator of the machine -- all rotate

around a single point in space with incredible precision and accuracy, so any of those movements, we still know that the target is being aimed at from any position.

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DOUGLAS BOCCUZZI, MS, DABR: That's a good point, Dr. Salner. When I mentioned the physics quality assurance before, what we're actually verifying is the reproducibility of the radiation isocenter, which on this machine is specified at 0.5 mm, half-a-millimeter of gantry rotation, and 0.75 mm, or three-quarters of a millimeter, for the couch rotation. So sub-millimeter accuracy.

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ANDREW SALNER, MD: One of the email questions that we have is, "What are the hazards of exposure for radiation for healthcare professionals?" And I would just mention that there's no exposure to radiation with this procedure because all the staff is outside the room when the actual radiation treatment or filming is performed. They're outside of the shielded space. So even for the patient, the dose to any other part of their brain or body is very, very low. Because the radiation is so extremely well-collimated with this type of treatment, there's very little radiation in the environment right outside the high-dose area.

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DOUGLAS BOCCUZZI, MS, DABR: The staff is also monitored using personnel radiation film badges. And these consistently give essentially a zero reading on a monthly basis, so none of our staff gets any exposure to radiation from this procedure.

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ANDREW SALNER, MD: Right. Another question we have is, "Can the treatment be used for prostate cancer for the prostate if it's not removed or after prostatectomy if radiation is required after surgery?" And I would mention that we use similar technique called intensity modulated radiation therapy for prostate cancer, where we do immobilize the patient utilizing a body cast, and we do use daily image guidance like you've seen with the OBI. But we don't use stereotactic treatment, we use intensity-modulated radiation with image guidance, a similarly accurate technique but not quite as accurate as the stereotactic technique itself.

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DOUGLAS BOCCUZZI, MS, DABR: We've actually already completed two of the ten beams of the treatment. Elaine just went into the room to move to the third position. So the treatment itself actually goes quite quickly with the system.

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ANDREW SALNER, MD: One of the questions, Doug, via email: "Is there a strong magnetic field around the machine?"

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DOUGLAS BOCCUZZI, MS, DABR: There are some electromagnetic fields in the room, not strong. You can be treated if you have a pacemaker. There aren't concerns about that. But there are -- the accelerator works via a radiofrequency generator, so there are some fields in the room, but --

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ANDREW SALNER, MD: Not judged to be harmful to patients?

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DOUGLAS BOCCUZZI, MS, DABR: No, not at all.

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ANDREW SALNER, MD: Thank you. Susan, maybe you could make a quick comment on when do you select single fraction stereotactic radiosurgery versus fractionated stereotactic radiation therapy for patients with an acoustic neuroma?

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SUSAN Y. KIM, MD: I think the major difference how those two modalities are chosen is based on hearing preservation. If the patient has reasonable hearing left with speech discrimination, I think it's important to try to preserve that as best as you can. There is

literature support to indicate that fractionated regimen may be slightly superior in hearing preservation than single fraction. I think the data says about 50 to 70% hearing preservation with single fraction. With the fractionated regiment it can be as high as 70 to 80%. Of course, long-term data still needs to mature, but based on the current data, I tend to advise fractionated treatment if there's hearing reserve.

00:42:16

ANDREW SALNER, MD: Okay. Thank you. And that little beeping sound that we heard was how fast the treatment is. It's a matter of seconds from each angle, so it's very fast, and here you see the gantry and the couch being rotated to the next treatment position. How's the patient doing?

00:42:37

SUSAN Y. KIM, MD: How's the patient? Patient is doing great.

00:42:40

ANDREW SALNER, MD: Good. Of course, we maintain contact with the patient all the way through and say hello and make sure she's doing okay. So Susan, she'll have a series of 30 treatments daily over about six weeks, right?

00:42:56

SUSAN Y. KIM, MD: Yes. Actually, because she had such a small tumor, I chose to give her 5,040 centigrade in 28 fractions. And she's about halfway done already.

00:43:08

ANDREW SALNER, MD: So five and a half weeks of daily treatments, five days a week. And she's in the department for what, about 20, 30 minutes a day?

00:43:15

SUSAN Y. KIM, MD: About 20, 30 minutes. The patient actually measured the time, I believe, and she says it's 12 minutes, so --

00:43:23

ANDREW SALNER, MD: Wow. That's pretty fast. And how is she feeling during this? Is she able to drive and function during these 5.5 weeks or is she feeling any side effects?

00:43:33

SUSAN Y. KIM, MD: She reported a little bit of fatigue, but otherwise she has not had any side effects whatsoever. She's done very well, tolerated very well. At the beginning of the treatment, the -- with the mask system sometimes there can be a slight shrinkage of the mask over time where it does become a little bit too tight, and we do have to modify that by using some of the spacers that we have. And once that was adjusted, the patient was quite comfortable and was able to tolerate all of the rest of the treatments without difficulty.

00:44:05

ANDREW SALNER, MD: I think part of the beauty of stereotactic treatment is that the dose is so localized, the patients have very few side effects. Will she lose any hair?

00:44:15

SUSAN Y. KIM, MD: It is unlikely. There may be some partial hair loss on the left side, maybe the left temporal area, but that will come back.

00:44:22

ANDREW SALNER, MD: Yeah. So hair loss is much less with this technique than when we're using larger, more conventional brain fields. Are there risks -- are there long-term risks, Susan, in terms of this treatment?

00:44:43

SUSAN Y. KIM, MD: Certainly there is a theoretical of secondary malignancies occurring in patients who get radiation therapy or radiosurgery. I think the -- my belief is that developing a new cancer somewhere else in the body is a much higher risk than actually developing a secondary malignancy from radiation. So I don't think that is usually used as a factor to determine whether the patient should be treated or not.

00:45:13

ANDREW SALNER, MD: Yeah. One of the studies that I've recently read indicates that they project a theoretic risk from this treatment for a second malignancy of approximately 0.8%, so it's very, very low.

00:45:30

DOUGLAS BOCCUZZI, MS, DABR: We're now delivering the last beam. We're all done.

00:45:33

SUSAN Y. KIM, MD: All done.

00:45:35

ANDREW SALNER, MD: Wow. That was amazingly fast. And we sort of talked through a lot of the treatment, but I think the audience could certainly hear the beam-on time, which from each of the 10 angles was very short. And here you see Elaine loosening the mask, taking the clamps off the mask, and removing the anterior half of the mask system from the patient. And the patient is pleased to be finished with treatment for today. The knee sponges, by the way, are a way of keeping the patient comfortable by taking the pressure off her back by putting her knees up in the air. And Dr. Poletti, who is also an expert on back issues, is certainly supportive of that idea, making sure we keep the strain off the spine. One of the email questions, "What is the prognosis of different brain tumors after treatment with stereotactic?" And they mentioned glomus tumors, and they mentioned astrocytoma grade IV. I'll talk about glomus tumors. Glomus tumors are tumors of the vascular structures around the carotid, pharynx, and jugular, and we frequently use radiation to treat them. And we tend to use -- because of the size and shape of them, we tend to use fractionated IMRT to treat them because they're frequently wrapping around the pharynx with quite good results. Patients used to have a lot of pharyngitis from that treatment and now have very little. We will occasionally use stereotactic treatment, as the tumors are intracranial for glomus tumors. For astrocytomas grade IV or glioblastoma, of course those are very difficult tumors to treat with -- no matter what we do. And as I mentioned earlier, because they tend to be larger, we tend to use IMRT to treat them and will sometimes use stereotactic treatment as a boost to increase the dose safely. And those patients also get concomitant chemotherapy with temozolomide. And here's the patient walking out of the room with Susan and saying goodbye to the staff. She'll be back with us tomorrow for her next treatment.

00:47:59

SUSAN Y. KIM, MD: Thank you, Jean.

00:48:02

PATIENT: Thanks very much.

00:48:03

ANDREW SALNER, MD: We have a few more email questions while the gang says goodbye to our patient and she's heading back home. "With fractionated stereotactic treatment" -- Susan, this one's for you.

00:48:15

SUSAN Y. KIM, MD: Okay.

00:48:16

ANDREW SALNER, MD: "With fractionated stereotactic treatment do you deliver a higher total dose to the target when you would give it as compared with giving it in a single fraction?"

00:48:24

SUSAN Y. KIM, MD: Well, I can talk about acoustic neuromas. With the single fraction treatment we give about 12 to 13 gray as a single dose. That is equivalent to about 3 to 4 times equivalent to a fractionated dose, so it's not really that different when using a fractionated regimen versus single fraction.

00:48:45

ANDREW SALNER, MD: But with this patient you're giving fractionated you're giving 50 gray.

00:48:49

SUSAN Y. KIM, MD: About 50 gray.

00:48:50

ANDREW SALNER, MD: And with a single dose you're giving 13 gray.

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SUSAN Y. KIM, MD: About 13 gray is the maximum dose. And historically they've used higher doses -- 18 gray, 20 gray. There were a lot more complications, especially facial and trigeminal dysfunction. And while reducing the dose, the local control rate did not decrease, but the side effects did reduce, so the current standard is 12-13 gray.

00:49:16

ANDREW SALNER, MD: One of the points we wanted to make was that the local control rate with various studies with stereotactic treatment is estimated to be in the 95-96% range.

There are still a few patients who will have tumor progression, and I guess the question back for Charles is what happens in those rare cases where we see tumor progression despite radiation? Is a surgical approach possible in those patients?

00:49:47

CHARLES E. POLETTI, MD: Yeah. I think if you -- I've had several patients. The number of patients who grow in spite of truly confident stereosurgery is somewhere between 3 and 5%. I've operated on three such patients, and I've done a conservative intracapsular removal. This very often is enough to provide the patient complete freedom from their attack to their cerebellar signs, their other complications. And surprisingly, perhaps the blood supply is -- along with the previous effect of the radiation -- is compromised enough that following these patients for a number of years, often they don't grow. So the answer is yes, you can certainly use surgery to -- as an adjunct if your original radiosurgery doesn't work.

00:50:47

ANDREW SALNER, MD: Susan, one of the questions from the email relates to the quality of hearing. I know there's a Gardner-Robertson scale that's used 1 to 5 based on how good the hearing is for patients. And some of the data from fractionated stereotactic radiation would not only imply that the preservation of hearing rate is better with fractionated treatment but the quality of the hearing is a little bit better. Do you want to comment on that?

00:51:17

SUSAN Y. KIM, MD: I can comment on a little bit. I don't think there's actually a lot of data on that. Certainly hearing preservation rate, and I think the way the measurement is done it varies from literature to literature, but the good news is that there is certainly high preservation rate. And in fact, in some radiotherapy series there's actually an improvement of about 5 to 7%.

00:51:41

ANDREW SALNER, MD: Hmm, interesting. Susan, what's the follow-up for these patients? After you finish treating them, how do you follow them?

00:51:47

SUSAN Y. KIM, MD: My general follow-up -- well, with all radiotherapy patients, we generally follow them at one month. But in terms of imaging, my usual would be about six months after treatment, whether radiosurgery or radiotherapy to do an MR imaging. One thing you must remember with a six-month period, there can be some peritumoral edema, especially for larger tumors, with radiotherapy and radiosurgery. And in fact can even look like it's increased in size. I think it's important for clinicians to realize that if the patient is asymptomatic that the patient should be observed because peritumoral edema can look like -- or there's sometimes increased enhancement that may look like increasing tumor but may not be in many cases, and they should continue to be followed.

00:52:37

ANDREW SALNER, MD: And these tumors of course are benign and their growth kinetics are very slow. And that means they're slow to grow, but that also means they're slow to shrink after treatment. When -- what's the earliest you would tend to see shrinkage in a tumor?

00:52:49

SUSAN Y. KIM, MD: You certainly can see some shrinkage even at six months. As I said, sometimes they do even increase in terms of appearance. About two-thirds of the patients do show shrinkage over time. It's slow -- six months, a year, two years. About a third -- of the 90% or plus control, about a third remain the same and about two-thirds shrink over time.

00:53:11

ANDREW SALNER, MD: Okay. But patients shouldn't be worried if there's no shrinkage at six months that the treatment didn't work.

00:53:18

SUSAN Y. KIM, MD: Correct. I think we have to measure tumor control as no growth.

00:53:22

ANDREW SALNER, MD: Right. Are there any contraindications to stereotactic radiation therapy?

00:53:28

SUSAN Y. KIM, MD: I can't think of any at the moment. Do you have any concerns?

00:53:34

CHARLES E. POLETTI, MD: Yes, if the tumor's larger than 3 cm, you don't want to radiate it. But I do think it's extremely important to say that the whole approach to acoustic neuromas has been changed. If you come into the office and you have a very large tumor, we can almost guarantee you that you will not lose function of either your -- especially your facial nerve and perhaps even your acoustic nerve by doing a conservative intracapsular removal. This means that you have a good chance of preserving your hearing even with a large tumor. You have a very good chance of preserving their facial function. Then when the tumor shrinks to less than 3 cm, and very often even a 5 or 6 cm tumor after intracapsular removal will shrink to less than 1, 1.5, and then at that point you give them radiosurgery. And so you've opened a whole new era of hope for people with very large tumors who before were very often left with a high incidence of deficits. And so now even people with very large tumors can do extremely well.

00:54:51

SUSAN Y. KIM, MD: I think that's a very important part, Dr. Poletti. Certainly with radiotherapy, as the tumors do not shrink very quickly and can cause a DMI, it is important to -- not to do radiation or radiosurgery in patients who have mass effect on the brainstem or do not respond to steroids. I think those are definitely surgical candidates.

00:55:14

ANDREW SALNER, MD: And it's interesting to note that we're talking about individually tailoring treatment and working as a multidisciplinary team much the way as we do with all the cancers we treat now. And even for a benign brain tumor where you think that "Gee, that's not as serious a problem," we still need the benefit of the multidisciplinary team to really help us in determining how we individually tailor a particular treatment for each patient.

00:55:37

CHARLES E. POLETTI, MD: Absolutely.

00:55:39

ANDREW SALNER, MD: And of course, again, the patient needs to be a participant and their family need to be a participant in that discussion because hearing may be a particular issue for that patient and that may help to guide treatment for another patient. It may be that they have -- that they want surgery. Or for another patient it may be that they have a concern about surgery, a concern about being on treatment for a number of weeks. So again, it's the active involvement of an informed patient and family that really makes a big difference. In addition to the MRs on the six-monthly basis for these patients, audiography is frequently done for these patients. Are there other follow-ups, instruments that you use for patients as you follow them?

00:56:22

CHARLES E. POLETTI, MD: No, I think it's very important not to operate on these lesions just because they're there. I think if somebody comes in to you and they're 70 years old and they've suddenly lost their hearing, this does not necessarily mean the tumor is growing. You can follow them with -- really, since they've lost their hearing, you follow them with imaging studies. And it's amazing -- Dr. Ojemann taught me this when I was under his tutelage up in Boston -- it's amazing how many of these tumors in fact don't grow and need no treatment. And for the first time the other day I actually saw a 44-year-old man that I'd been following for 10 years whose tumor actually got smaller without treatment.

00:57:02

ANDREW SALNER, MD: Huh. Interesting. Susan, here's another email question for you. "Can this procedure be repeated later if there is progression or have we reached the maximum dosage with the original treatment?"

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SUSAN Y. KIM, MD: I think that it is possible to redo radiation, but it is certainly a risky procedure, and I would not recommend a second radiation procedure. If a patient had radiotherapy, doing radiosurgery or vice versa, I think it's a surgical treatment at that point.

00:57:33

ANDREW SALNER, MD: Right. I would agree. I think you begin to increase the risk profile significantly for a patient by offering re-treatment. You certainly could treat other parts of the brain, right, Susan?

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SUSAN Y. KIM, MD: Sure.

00:57:42

ANDREW SALNER, MD: Because this radiation is so localized, obviously you'd have to study where the prior was given. But treatment of other parts of the brain or other parts of the body are feasible, but coming back and treating this area would carry with it a higher risk of injury to the brainstem, facial nerve, eighth nerve, and so we want to be really careful about that.

00:58:04

CHARLES E. POLETTI, MD: There's a whole nother group that we haven't mentioned, and those are people with neurofibromatosis who have bilateral tumors, and if they lose hearing on both sides, they're deaf. And by using this radiosurgery you would keep them very functional.

00:58:20

ANDREW SALNER, MD: Well, that's about all the time we have. I would like to thank everyone. This has been a demonstration of a brain tumor treatment using Trilogy Stereotactic Radiation Therapy live from Hartford Hospital in Hartford, Connecticut. I'd like to thank Hartford Hospital and its administration and board for buying us this wonderful machine, the Trilogy, first in Connecticut. I'm Dr. Andrew Salner. On behalf of Dr. Charles Poletti, Dr. Susan Kim, Doug Boccuzzi, and the rest of the dedicated professionals at Hartford Hospital, thanks so much for watching and good night.

00:58:58

ANNOUNCER: This has been Trilogy Stereotactic Radiation Therapy for brain tumors performed from Hartford Hospital. OR-Live makes it easy for you to learn more. Just click the "request information" button your webcast screen and open the door to informed medical care.

00:59:26

[end of webcast]