Awake Craniotomy

Methodist University Hospital
Memphis, TN
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Welcome to the Neuroscience Institute at Methodist University Hospital in Memphis, Tennessee. Methodist University Hospital is the principle teaching site for the University of Tennessee Health Science Center's Neurological and Surgical Residency Program, which, in conjunction with the Semmes-Murphy Neurologic and Spine Institute, is one of the most highly regarded medical residency programs in the nation. The Methodist University Hospital Neuroscience Institute is also the only site for adult neurological clinical research and development and features the area's only neuro intensive care unit.

In today's broadcast you will be part of history by watching the first awake craniotomy webcast in the Mid-South.

Awake craniotomy means that we're doing an operation in the brain with the patient awake during part of that operation. Obviously during most surgery patients are asleep or under anesthesia. So the difference for an awake craniotomy is that we've got a patient who can talk to us, who can move, who can interact with us at the very time when we're working in and around their brain.

The moderator of the webcast is Dr. Allen K. Sills Jr., a nationally recognized neurosurgeon with the Semmes-Murphy Neurologic and Spine Institute. Dr. Sills is the program director for the neuroscience institute at Methodist University Hospital and an associate professor at the University of Tennessee Health Science Center.

Joining Dr. Sills is Wayne Hamm, a key member of this highly-skilled team. A certified nurse anesthetist, Hamm is with the Medical Anesthesia Group and has more than 30 years experience in neuro anesthesia procedures. Dr. Sills is joined in surgery by Dr. Madison Michael, an assistance professor at the University of Tennessee Health Science Center and the director of the skull-based tumors program at Methodist University Hospital.

In difficult cases such as this, it's always nice to have the experience of two surgeons in the room. As you can understand, there are many decisions that need to be made throughout the entire surgery, and we do like two surgeons in the room on cases such as these so that they can tackle these tough decisions that need to be made. Methodist University Hospital is the only hospital in the Mid-South with the team-training, skill, and cooperation among neurosurgeons and anesthesiologists to perform the most advanced neurosurgical procedures, including awake craniotomies.

Awake craniotomies are generally always done for people who have tumors in eloquent areas of brain cortex, and they're usually done on patients who run the risk of either losing motor function or speech or both.

An awake craniotomy is not something that's available at every hospital. In fact, it takes a very unique hospital because it is a procedure that requires expertise and skill primarily on the side of the anesthesia team, as well as surgeons and nurses who are accustomed to doing this type of procedure. So really only highly specialized brain tumor centers are offering this type of care, and I feel like we're fortunate here in Memphis to have that resource available locally.

Look at this. Whoops. Come on.

Shila Mullins enjoys the outdoor. She likes to help people and does so often. She's a wife, mother, and doting grandmother.

Spending time with the grandbabies, that's a big job. It's a lot of fun. We have lots of fun. We do different things. We go to the park. We have lunch out. We go visit friends, just spend the day having fun, doing what she wants to do, as usual.

In 1997, Shila began suffering from seizures and had her first brain surgery. And in 2004, her symptoms reoccurred.

Well of course I was terrified. I didn't know what to do. Well somebody told me about Dr. Sills. Well I went to Met Cal and Semmes-Murphy, and he said, "I know a wonderful doctor." And he said, "I think he can handle your situation." So he told me about him. And I come home and I cried because I didn't know what to expect or what to do. All I could think about was being a vegetable. So I called Dr. Sills, made the appointment, went to him, and he said "I can do the surgery maybe as good as you are now?" And my words to him was, "Are you ready?"

Miss Mullins is a patient I followed for several years. She first had surgery about another surgeon a number of years ago, and her tumor remained under good control; however as we watched it over time, her tumor started to grow again. We knew that we needed to go in and take it out. We thought the safest way to do that was with an awake craniotomy so that we could remove as much of it as possible and yet preserve her important function located right next to the tumor.

I couldn't imagine having brain surgery being awake. And he said you're awake but you're not like we're awake here. He said, "We'll have to talk to you," he said, "because I don't want your whole left side." He said, "This tumor is pressing against the motor skill that tells you left side to work." And he said, "If we can't do it awake, I'm afraid it might paralyze you." I said, "Okay." I said, "I'm game if you are."

Shila was sent for a functional MRI to determine the exact location of her tumor. A functional MRI creates a map of the brain that indicates where language, motor, and sensory areas are located. It is incorporated into surgery to give the surgeons pinpoint precision while operating.

The functional MRI was very different. It was a lot more time to lay, but in the long run it was worth it because it told Dr. Sills how far he could go, you know, without damaging me permanently, and I think that was a good idea, you know, because there, again, he took that extra step for his patient.

I think Shila is an amazing lady, amazing in the sense that she has had this tumor for a number of years and yet she's carried on with life and has not allowed it to slow her down. And obviously when I had to give her the news that the tumor was back and that it was growing, that's devastating news for anybody. But it didn't get her down. She simply had the attitude of, okay, let's roll up our sleeves and get after it. So she's incredibly motivated and very courageous about that.

Now that you have met the patient and our team, let's join Dr. Sills and Wayne Hamm to discuss Shila's surgery. I'm Allen Sills, neurosurgeon, and I'm joined today by my colleague, Wayne Hamm anesthetist with the Medical Anesthesia Group. Both of us work here at the Methodist University Hospital here in Memphis, Tennessee.

And we're talking today about our patient, Shila, who you have already met and who you know already had a surgery for a brain tumor. Her tumor had reoccurred after a previous surgery and as we looked at taking her back to surgery, we discussed doing this with an awake technique, an idea where we could keep her awake for certain key parts of the surgery in order to map out the function of her brain, with the ultimate goal, Wayne, of making it as safe as we could for her and preventing any new deficit.

Certainly. The asleep-awake-asleep technique is currently the most written about in the literature. And it seems to provide benefits that we like in terms of the sleep and then it also allow us to have the patient awake whenever the patient's performance is required during the course of the operation.

Let's go ahead and take a look at some of the film from that surgery. What do you talk to the patient about beforehand and what are the keys points of that?

Actually we go over all the elements of the operation, but most importantly, we go over environmental considerations, things like what does the operating smell like; what does it sound like; what will they see; and when will they see it. These are the things that we like to go over and make sure that the patient fully is aware so that they are not caught by surprise and have any misgivings about the course of the operation at all.

And you can see during this first section of the operation that this patient doesn't look very awake. In fact, they look pretty asleep right now, and why is that?

Well this is the part of the operation that we consider necessary, to have them asleep so that we can do the painful parts of the operation; establishment of the IV, such as what you see in her neck; placement of the LMA so that we can ventilate the patient while they're asleep; actually the placement of catheters; placement of the Mayfield headrest.

Now one of the things that I also know that you spend a great deal of time working on is making sure she's comfortable. And that comes in the form of padding and that comes in the form of how she lays.

The most important thing about the positioning is to make sure it's consistent with what you tell the patient on the front end. Whenever we talk to the patient on the front end, we tell them that their arm will be placed across their chest; that they'll be in a semi-sitting position; that their head will be somewhat relaxed. She'll look somewhat like this; and by doing that they know what to expect whenever they wake up. If you don't warn them about this, they'll feel claustrophobic. This woman already has a history of claustrophobia, and we certainly don't want her to feel any worse.

Whenever the patient emerges from anesthesia, the first part, the sleep part of the procedure, she will wake up inside of a tent-like structure, and it's very important that they understand that they're going to wake up not seeing anything external, but they will have a light on the inside. The lights in the room itself will actually be out, so whenever she awakens, she will awaken inside after lighted tent. So hopefully this will alleviate some of the fears.

Shila's tumor was located in an area of her brain that was near control centers for motor function. Obviously different regions of the brain control different functions, and it's not possible to absolutely predict what function is located where based just on the anatomy of the brain. That's why it is important to have the patient awake during the procedure so we can see which function is controlled by which part of the brain.

On the other hand, we do need valuable real-time information about the location of the tumor while we're doing the surgery because many times the tumor merges into the surrounding brain tissue. I often tell patients that these tumors grow like weeds grow in your yard, where bad cells grow in among good cells, and it becomes difficult to tell where that border is.

So one of the devices that helps us with that is what's called the "Stealth Navigation Device." We take an MRI scan of patient. We then take that scan and merge it onto a picture of landmarks on the patient's skin and skull. And then when the patient is in the operating room, we can create a model of the skull, the skin, and the brain, which allow us to then touch, with a probe, different points on the brain, skull, or skin and see where we are against the patient's MRI study. This has been a great advance. It really helps us as surgeons be safer and more precisely localize areas of the brain where we're trying to reach.

The way that this navigation system works is that we have a reference arc that's being placed and seen by a camera that's located in the operating room. This arc is a fixed distance away from the skull and the brain. We then have a TV screen that shows us pictures of the brain in different dimensions, and then we have a probe that we can touch against the reference arc, measured with a camera, and we then translate those points into points on the skull, the skin, and, eventually during the course of the operation, in the brain. The computer updates this and show us pictures in three dimensions and also gives us some sense of our direction much like a GPS device would in a car as you're traveling down the road.

Here we're making an initial incision where we reopen the skin from the site of Shila's previous surgery to allow us access down to the skull, and ultimately down to the region of the tumor.

The first sections of the operation consist of reopening the previous incision and then removing sections of bone that allow us access to where the tumor is located. We set those pieces of bone aside and we'll put them back in later in the surgery. Then we begin the process of allowing Shila to wake up, and that is a gradual process that occurs over a few minute's time. At the initial part, Wayne, she's not fully awake quite yet, and you have to remind her about the environment and what's going on.

We do our best to try and make sure that she feels as comfortable whenever she wakes up and that she doesn't feel alone. Shila? Shila, talk to me now. You doing all right?

Miss Mullins, It's Dr. Sills, everything's going fine. You're doing just great. Here we're using an ultrasound probe. An ultrasound is another technique that we use to localize the tumor. We talked earlier about the Stealth station, but ultrasound gives us real-time information that we can compare and use in addition to stealth. So by using both of those methods, we feel like we get the most accurate picture of exactly where the tumor is located. And this is the same type of ultrasound probe used, for example, at looking at a baby in a mother's womb or many other applications in a body. It shows us the different tissue, because tumors usually have a different consistency to them than do the areas of surrounding normal brain.

You'll notice as Shila's starting to wake up that Wayne's actually there and making sure he's very close to her and talking to her, Wayne, and letting her know that things are going just as we expected.

It's not at all unusual whenever people wake up and they have had medications, it's not like waking up from a regular sleep, so you don't immediately become conscious of where you're at. So it's very important that they receive a fair amount of reassurance, and make sure that these people are comfortable. Shila, be still. Do not move, Shila. And you will notice that one of the things that seems to be consistent and we have seen this in most of these patients is they're really not hurting, despite the fact that we've opened the skin and we're removed part of the bone. This isn't really something painful for the patient.

No. In our experience we have done many of these, and the patient's nearly always have very little, if at all, any pain.

Shila? Shila?

Huh.

There you go. Talk to me a second. Can you hear me?

Yeah.

Tell me your name.

Shila Renee Mullins.

Okay. Now what are you not supposed to do?

Move.

There you got. You got it. Now who's your doctor?

Dr. Sills.
That's super. He's doing your surgery and everything's fine.

Shila?

Yeah. Tell me your name.

It's not as if they feel us working on them, sort of like you might feel the dentist still drilling on your tooth even if you can't feel it directly, you might feel the vibrations. Typically by this point of the surgery when the bone has been removed, they're really not even feeling any vibrations or any pressure from where we're working.

No. And the biggest complaint usually is that they feel like they're tied down a little bit and that they can't move their extremities enough.

Here we see us opening that covering of the brain, and that was a little trickier in Shila's case simply because she'd had surgery before. And any time someone has had surgery before there will be some scarring of that covering to the brain, and we have to take a little time to delicately open that and make sure we don't injure anything as we're opening up. The brain has a very thick fibrous covering over it calling the "dura." It's like a thick leathery membrane as you see here. Once we get that open, we'll have the surface of the brain exposed and then we can go about sorting out what's tumor and what's normal brain.

Shila?

Uh-huh.

Just so you'll know, everything is going well. Okay? They're doing your surgery.

Okay. And you're not hurting any; right? You feel halfway decent.

Uh-huh.

If the patient is experiencing any discomfort at this point, Wayne, you certainly can treat that with some low-dose medications, or we can give more local anesthesia to make sure they're comfortable.

That's been our experience in the past, and again, we have not had to resort to giving additional medications during the course of this particular part of the operation.

As the patient wakes up and they begin to hear what's going on in the operating room, one of the things I find helpful is reassuring the patient, letting them know what we're doing and that things are going well, and that we are moving along as expected and also when they can expect to maybe hear a loud noise or use of a piece of equipment, something like that so that doesn't startle them.

Whenever we talk to them preoperatively, we oftentimes go over the fact that as they emerge, quite often they will hear the drilling, and the sound of the drill is very much like going to a dentist's office.

Again, one of the things we're seeing here is that there's a little bit of scarring between the covering of the brain and the surface of the brain, and this is simply because Shila has had surgery before. This would not be present in someone who was having surgery for the first time. It causes us to take a little bit more time to open that and to make sure that we have a clean field in which to work.

Dr. Sills, I know oftentimes, people think that you're going to be in my mind, isn't it going to hurt. Why doesn't the brain hurt?

It's a great question, and we also try to make sure patients understand that for something to hurt, you have to have pain receptors. You have to have nerve cells designed to feel pain. And we simply don't have any of those in our brain, so that's why there's no actual pain generated from us working on or in or around the brain itself. The pain would come from areas like the skin or the skull, and that's why we work on those areas initially while the patient is still fairly deep asleep. Once they get to the point of being fairly awake, we're no longer working on painful areas.

Here we can see the surface of the brain exposed. Toward the back of the picture is the more normal-appearing brain tissue. The tumor is to the front of the picture, and we'll spend, now, some time trying to localize what's bad tissue versus good tissue.

Shila, this is Dr. Sills. You're doing just great. Everything's going really well. Okay?

Thank you.

You comfortable?

Uh-huh.

Okay. We're going to be just measuring a few things, looking at a few things up here, so you just hang out for a second, and then I'm going to talk to you and have you do some stuff in just a couple minutes. Okay?

All right.

But everything is going great. If you get uncomfortable, you let Robin or Wayne know over there.

You're a great doctor.

And we'll add it to their bill. How is that? Is that a deal?

I don't care. So long as you fix me up, I'm all right.

Not your bill, there bill. I put it on their bill.

You could see that the brain actually pulsates with each heartbeat. It goes up and down a little bit, which is normal. And it also will move up and down some with each breath that we take, something that people don't often realize.

Here we're using the Stealth probe, the navigation system that we talked about before. And as we touch different points on the brain, we can see that three-dimensional picture on the TV screen showing us where we are in relationship to the tumor tissue and also to the normal brain. This, again, is why the head must be kept completely still, because obviously if the head moved, it would invalidate our navigation.

We use this information, combined with the ultrasound, combined with what we see at surgery, and also in combination with our functional mapping in order to determine what tissue needs to be removed and what tissue needs to stay behind. In this section of the surge are we're putting a device called a "grid" on the surface of the brain. And each of the silver dots is an electrode, a place where we can record electrical signals. And that's literally what we're doing. We're measuring electrical activity in the brain.

That's how the brain works, by bursts of electricity between cells, and normally those bursts are very controlled and are of a certain size and certain duration. In someone who has seizures, those bursts of electricity get out of control, and they become too large or too long in duration, and we can actually measure that through this grid, which hooks up to a series of wires that run off to a machine that we monitor.

All right. Let's do a little functional mapping here Wayne. Now we're going to turn to the actual functional mapping where we want her to perform different tasks. And we start out with some speech tasks, just because that's the easier to understand and allows us to make sure that she can understand us and communicate with us reliably.

Okay. Shila, in just a second, I'm going to start asking you to do a few things as far as squeezing or talking. Robin and Wayne will tell you what to do over there. Okay?

Okay.

If you're hurting or anything is uncomfortable, you just let us know. You're doing great.

I'm not hurting.

Good. You're making our job really easy.

This is clearly the crux of the operation here, Wayne. This is the part of the surgery for us where we want the patient awake and able to interact with us, because we need to be able to ask the patient to do certain tasks while we measure the function of different parts of the brain. And so this is really the part of the operation where the patient is the most awake and most able to converse with us. All right, Mark. I'm going to come off.

Okay. Let's do a little speech work here. You want to do some ABCs.

Uh-huh.

Okay.

You want to say your ABCs.

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z.

Yeah, okay. You want to count? Now real slow you want to count the numbers.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

The device we're using is and electrode that provides electrical current to different parts of the brain. And this current overrides the normal currents that are present in that area. So if we are stimulating an area that's controlling the task that we're asking her to do, she won't be able to complete that task because that area of brain will be temporarily rendered inoperative. So we move this probe around to different parts of the brain, looking to see exactly what function is controlled where.

Can we get a little irrigation. Mark, can you turn this up to four, please, on the milliamps here. Okay. Let's go again on the talking please.

Let's do the alphabet again.

We use different amounts of current because sometimes it takes a fair bit of current to show which area of function is active and to overcome that function. Every patient is a little different in that. We simply have

to start with a low amount of current and then work our way to higher level's, depending on each individual patient's anatomy and the particular tumor that we're taking out. Okay.

Let's start with January.

January, February, March, April, May, June, July, August, September, October, November, December. January, February, March, April, May, June, July, August, September, October, November.

During this time, we're stimulating both normal and abnormal parts of the brain, in other words those parts that are involved with the tumor, as well as particularly those parts of brain that are immediately adjacent to the tumor, because those are the parts where we're going to have to make decisions about whether to remove that part or not as we take out the tumor.

Seven, six, five, four, three, two, one.

Very good. You want to do it one more time.

Ten, nine, eight, seven -- I don't know if I'm cold or not.

You feeling a little shaky?

Just feeling a little cold?

Uh-huh. She's a little built shivery. We got her warming blanket on her.

A, B, C, D, E -- ten, nine, eight, seven, six --

She's lifting up her left arm now.

-- five, four --

Shila, can you relax that left arm? It's turning and lifting up.

So one of the things we're seeing here, Wayne, is that her arm starts to move involuntarily. And what does that tell us?

It tells us that we're beginning to experience some seizure-like activity. This is another thing that we discussed with the patient on the front end, and we have a number of options in how to deal with this.

And obviously these are not full-blown seizures where someone might think of someone's entire body shakes or where they lose consciousness. These are simply -- I know they can be, but typically we're looking at milder forms of seizure, which is what we see here.

Take it down to two please.

Just relax. Shila, can you grip my hand with your left hand. There you go. Now let me go. Very good.

Good squeeze again, left hand.

Yeah, squeeze real hard, Shila, with that hand. She's squeezing and pulling too. Okay. Let go, Shila. Can you just grip, Shila, without moving the arm. Just grip. There you go. Now let go. Very good.

How about, Shila, thumbs up over there.

Just your thumbs, Shila. Just your thumb up in the air. Can you do it? Unable to do that. She's trying though.

Can you show two fingers on that hand?

Open your fingers real big. Open your hand up big.

Shila, show me two fingers on your right hand. Now show me two fingers on your left hand.

Now we have moved on from talking about language to looking at motor function, and so we're asking Shila to do some tasks, and we're seeing how she moves in response to those requests. And you may want to talk about what types of requests we ask her to do and how she responded.

Probably the easiest things to look at whenever you are trying to get these patients to give you motor information is not just the motion, whether they can wiggle their fingers or their toes, but you actually need to feel the intensity of their squeeze. You need to be able to see if they can do individual fine motor movements with their fingers or their toes. So you're looking at a whole constellation of images.

And we knew that in Shila's case that her left arm, and particularly her left hand, was the area most likely to be involved with this tumor and the area that we were most concerned about being negatively affected by her surgery, and certainly this part of the mapping that that area was, indeed, very, very close to and, in fact, involved somewhat by this tumor that we found. We'll see these sticky numbers that we put on the surface of the brain. These are markers that tell us which areas were important to function and so we then can use that information as we go about removing the tumor to know what are safe zones versus unsafe zones. And now.

Come up again, Shila. Up on the left.

And now.

Again, Shila. Excellent thumb up on the left.

How about two fingers there.

Hold up two, Shila. Let me take that off because it's bugging you. I'm going to take that off. Okay. Two, fingers, Shila. She's got them.

And again.

Do it again. There you go. Perfect.

All I'm saying is I need some water.

Everything okay there?

Yeah.

Good. All right. Let's do a little foot work. Can you try -- we're going to want you to just wiggle your left foot around and your right foot around a little bit.

I can walk.

You can walk? Well let's hold on that for just a minute.

Can I walk now?

Not quite yet. How about now, can you wig that left foot

Shila has a great sense of humor, and not only was she very cooperative during the entire mapping but she kept us entertained a well.

We certainly enjoy that. Any and all entertainment is appreciated in surgery. Not only that, but I think it was important to her that she wanted us to know that she was still okay and that nothing that we were doing was interfering with her and that not only was she okay for then, but she was determined that she was going do get back and do all of her regular activities. And obviously that was our goal as well to make sure that she got back doing that in as safe a way as we can.

And let's just, can we get a little tap, maybe thumb and first finger together. Show her what you want her to do there.

Shila, can touch these two fingers together right here. We're going to get you to do this right here. Okay? Just like you're trying to snap your fingers. All right. You ready? I'm going to hold your arm though, so it doesn't come up too high. Now tap your fingers together for me. Unable to. They're holding together. See if you can tap them Shila. Unable to tap them. Still holding them together. The arm is pulling up and rigid.

So in this footage we're seeing a lot of effort expended towards measuring Shila's hand function. And it's not just her hand as a total unit but actually even individual fingers. You want to talk about being able to map out the function of individual function of fingers.

Oftentimes I have the patient lift up their thumb and squeezing, holding up two fingers, and we do this for a couple of reasons. Not only are we looking at individual finger movements, but we're also trying to evaluate the patient's compliance with our request.

Right. And there's something to be said about motor planning. In other words, to make a motion is not simply just making the motion. The brain actually has to plan that motion and decide how many muscles to recruit and to use. And some of those same pathways and control centers can be affected by the tumor. And the net effect of that is still impaired movement.

Still rigid and some rhythmic movement of the thumb.

Did I get it?

Yeah, you're fine, sweetie.

How about those four fingers now. Can you show us four?

She's got four up. Excellent.

All right. Go down to three now.

Okay. Put three fingers out, Shila. Her hand's clenched and rigid. Okay. Three fingers out, Shila.

And you can see that as we stimulate certain areas that are important in control, she will lose control of those functions temporarily while we're stimulating with the probe. Once we remove that stimulus, then she can get back and that area works normally. So this is how we can tell in real time exactly what function is being controlled by each really literally each millimeter of the brain tissue that we're looking at.

Okay. We're going to let you take a break for just a second. Can we get the microscope over, please.

Take a nice slow deep breath and just relax.

At this point, the operation transitions a little bit. Now we have done our transitional mapping. We have identified areas of brain that we want to stay out of and which areas are controlling which function, and

now it's time to get down to business and take the tumor out. As we do so, the patient is still awake however. And is the removal of the tumor uncomfortable in any way for them?

Certainly not. The patient is quite comfortable during the course of this. And as Dr. Sills pointed out earlier, the brain feels no pain. So as a consequence, the patient is totally unaware that the tumor is being removed.

But why, then, would it be important for us to have the patient awake during this part if we've already got that information about function?

Well, again, as you saw on the video, we have a demonstration in terms of the numbers, but we don't know how much of each number is involved. So as Dr. Sills removes tumor, he can take tumor in smaller slices, and we can evaluate each time he takes a piece of tumor.

And, again, I think it's important to understand that all of these areas, particularly underlying these numbers, there are connection wires that are connecting one area of the brain to the other. Of course those wires are way too small for us to see, even using the microscope that we use, and so as we go and remove tumor, we could disrupt some of those wires and communication, and that's why it's important that the patient can still work with us and talk to us during the removal.

Here we're working under the operating microscope. It's something that magnifies our vision for us and lets us see the brain tissue. And here we're starting to remove the tumor. We've identified areas that we think are clearly bad and areas that we think are clearly important. And our job as surgeons is to work right on the border between those two and to make sure we stay in the bad stuff and leave the good stuff behind.

Let me see the Stealth probe for a moment, please. As we do this, we're obviously evaluating how the patient is doing and whether they're losing any function. And, again, here you see our GPS-type probe, the Stealth probe that we're putting on the brain and looking at where we are relative to those images showing us the anatomy of the brain as we go through and remove different areas.

Okay. You can come up. All right bipolar, please. All right. Dr. Weimer, let's go ahead and we'll get some specimen out of this area here. Let's go ahead and take it out of here.

One of the other things that we do early on in the surgery, you'll see us taking a small piece of tissue here. We want to take that tissue and we send it off to our pathology doctors. The pathology doctors will take that small sample of tissue, they'll freeze it immediately. They'll slice it and look at it under the microscope, and they'll give us the first initial impression of what type of tumor this is and what grade of tumor it is. How aggressive is this tumor and what is its relationship to the normal brain tissue. That's important information for us as surgeons because it determines how we're going to proceed in taking the tumor out and what we may find as we do so.

Can we interrogate the hand a little bit there, please, Robin.

To actually remove the tumor, we have to separate it from normal tissue, and again, you can see that we're getting the patient to do tasks as we do this. One of the connections between tumor and normal tissue are these small blood vessels, and you'll seal us coagulating these or heating them up with an electrical current and cutting them so that we can actually separate the tumor from the brain.

Three fingers. Now hold up all of your fingers. Open your hand wide. Very good. Now grip my hand. Good girl. Now relax it. Pick your thumb up again.

The brain has a very rich blood supply, and the tumors have even a greater blood supply that they attract to themselves. In fact, they attract blood vessels to grow into themselves from normal areas. That's how they stay alive and nourish themselves, and so we spend a great deal of time to safely interrupt the blood flow to the tumor, as well as separating it from normal areas.

Move your fingers out. Good girl. Now grip my hand. Grip hard. Okay. Now open up your hand again. Relax. There. Now thumbs up.

I can move my fingers and my feet, Dr. Sills.

Yeah, you're doing good. Now thumbs up for me. You got to keep doing this, and it will get tiresome, but have to keep going.

It never ceases to amaze us or other people who observe this surgery that you can be in here actively removing a tumor and separating it away from normal brain and yet the patient is moving, talking, and doing all these tasks that we're asking them to do, all the while, not experiencing any discomfort and helping us along the way by cooperating with us in this manner.

Okay. We should be good on that. Let's just check the foot for a second.

Tap your left foot.

I can move them.

Yeah, that's good.

Dr. Sills, I can work a gas pedal.

You're doing great. Here Shila is assuring us that she can still move her foot and that that part of her brain is working just fine.

Going on tapping. You're doing wonderful.

There, that's good.

Now relax, Shila. Very good. Take a nice breath, honey, and take a little break. Very good, Shila.

You're doing just beautifully. You're making this look easy.

Let's Get a micro scissor, Dr. Weimer, please.

As we move through different sections of removing the tumor, you can see that it has some attachments to areas where Shila's previous surgery was, and so we're taking down some of those scar-tissue bands that were present before. Again, primarily we're using electric current to heat up the tissue and then allow it to cut away, cutting away bad stuff and leaving behind the good stuff.

You said you were going to bring me a steak tonight, didn't you, a steak.

A steak? Yeah. Wayne promised that?

Yeah, you did.

I did? All right.

He's going to delegate it to Wayne, it sounds like.

I'll have to see what I can do. I want to make good.

Uh-huh.

I don't remember that promise, but I'm make good on it.

And, again, even as we're working, we can still interact with the patient and talk with them. And, in fact, it's somewhat reassuring to hear not only from you, Wayne, on the anesthesia side, but also from us on the surgery side so that they know that we're finding what we expect to find and that everything is moving along well.

For the patient who cannot see the surgeon, the voice of the surgeon is quite reassuring, because at least the patient knows that the surgeon hasn't gone out for a steak dinner.

Here you can see we're about to fully remove the attachments of this large tumor from the surrounding brain tissue. We're working on the last few strands that connect the tumor to the rest of the brain. And once we're able to remove those attachments, we'll be able to remove this tumor as one large piece, which is how we prefer to do that so that we can clearly see that we've left behind good tissue around this area and that there are no bad cells left behind as near as we can tell.

And here you can see the full tumor piece coming out. It's a fairly large-sized tumor, and we'll now send this off for additional analysis by the pathology doctors. That analysis will take place over the course of the next few days, and it will give us a much more detailed look at the character of the tumor and how its related to the degree of malignancy that might be present.

Unable to raise her thumb. Shila, can you make a fist and squeeze my hand?

Do it on the other hand.

Unable to do that.

Squeeze my hand on there. Good girl. Put your thumb up.

At this point in the operation, Wayne, an interesting set of events happened. We noticed that she was getting a little weaker in her left hand, and that was because the bad cells were actually invading into areas that we knew from her mapping were actually important. And so we had to make some decisions of removal of tumor versus preservation of function.

This hand over here, your left hand, thumb up Unable to do the thumb up. Squeeze my hand. Unable to squeeze. Open your fingers up, Shila. Unable.

All right. Let's just let her rest for a second.

Okay. Take a little break, Shila. Take a nice deep breath and relax.

Sometimes going in and removing a tumor will actually stir up some swelling, and so a patient's strength might look a little worse temporarily. Additionally though, we know that going in and fully removing the tumor may put us into the edge of some of those important areas, and so the patient may actually get a little bit of worse from that work there, but we expect that that will get better over time since we know that there is still at least some function there. In other words, we're not completely disrupting that function. We may just simply be diminishing it temporarily.

And I think, again, as a surgeon, that's one of the great benefits having the patient awake. Because if we have the patient asleep, we have no way to know that that area was functionally important. And if the tumor led us into that area, we might wind up taking out more of that important tissue than we would otherwise intend to do so.

In Shila's case here, as we said, we noticed that her left arm was starting to get somewhat weak. But because we felt it important to remove as much of this tumor as we could, we were willing to accept a little bit of that decreased function. Obviously it makes sense that the more tumor we can remove the better

the patient chance is of fighting that tumor. And while we can never say we gout every single bad cell, clearly our goal is to take out everything that looks abnormal in that area.

Here he comes. Here he is right here. Doctor?

Yes, sir. It is tumor. I think I can say it's high-grade glioma. It's very cellular. The nuclei are pretty nucleomorphic. It's got the scattered mitoses in it. There is some necrosis. Has she had radiation?

I don't think she has, no.

Okay. Well that makes me feel even more like it's high-grade. The only thing I don't see is (INAUDIBLE) proliferation. But I think we're good for high-grade.

Okay. All righty. Thank you. Our interaction with the pathology doctors is extremely important because that information about what we're dealing with helps guide us as surgeons to know how aggressive we should be. Is it important to remove the entire tumor, or can we leave behind a small amount to be treated by other means? We also want to know in the case of Shila whether this tumor is the same tumor she had before; whether it's changed into something more aggressive and more malignant.

Move your right arm for me. There you go. Move your left arm. Pick your left arm up. That's good. Wiggle the fingers on your right hand. There you go. Wiggle the fingers on your left hand. Okie doke. That's all right. Everything looks fine. You're doing great.

You sure?

I'm sure.

Okay.

Dr. Sills would shoot me if told you otherwise.

Again, here you're see Wayne interacting with the patient and helping her not only with her comfort but checking, again, about different functions. You can see that the foot is working really, really well. Her hand and arm are showing a little bit of signs of weakness as we expected from our mapping.

Can't do much else. Okay. All right. Thanks. Good.

Here we're going around and trying to make sure that we have taken care of any bleeding that might occur. One of the biggest complications that we worry about after surgery would be bleeding where we have removed this tumor. And that's because, again, there are a number of very fragile blood vessels that are surrounding the tumor, and any of those can cause some bleeding after surgery, which can obviously cause problems. So we spend a great deal of time going around carefully sealing those off.

Here we are injecting a material that actually looks like tooth paste but actually is a collagen type of material that will lay against the surface of the brain and help to seal off some of those very, very small blood vessels. We'll leave that material on there and cover it with some other material for a few minutes, again, to allow some of the blood cells to come in and seal themselves off and prevent further bleeding. In fact, it's pretty common, in our experience, that we may spend more time actually making sure there's not bleeding than the time it took us to remove the tumor, simply because of this critical importance of avoiding bleeding after surgery.

All right. You got that one-by-eight strip, the electrode? Do we keep it up here?

At this phase of the surgery, we're doing some additional mapping for seizure activity. We knew that Shila had had some difficulty to control seizures prior to control surgery, and so we're using the grid, again, to make sure that there are no areas that seem prone to seizure that are left behind. It's our

assumption that it was the tumor that was triggering the seizers. It is in most cases. But we want to make sure we've done everything we can to eliminate her seizures, so we'll do recordings again with the help of Mark and the EEG team to make sure that there does not appear to be any areas prone to seizure left behind here.

All right. Now can you straighten your fingers out on your left hand?

Not quite.

That's fine. That's fine. The important thing to remember now is that you've got good movement in this arm.

Your fingers and everything are fine. Dr. Sills is real pleased.

Well, I'm glad.

You be sure and tell your husband. He's been up there looking around for the last 45 minutes, and he hasn't seen a bad thought yet.

Okay, Mark, let's do a little measurement there -- medial.

Okay.

I'm going to reposition one more time.

At this point, we're making our final measurements, making sure there's no abnormal seizure activity that we see and determining that we have taken out all of the tumor that we want to remove and that we're ready to finish the operation and close everything back up.

Okay, Shila?

Uh-huh.

It's Dr. Sills again. You have done beautifully. We're all finished up. We've taken out everything we need to take out.

Thank you.

At this point we're just going to be closing everything up, so we're going to kind of let you drift off to sleep again. Okay?

All right. Thank you.

You were a trooper. You did beautiful. It wasn't too bad, was it?

No.

All right.

We're going to close you up and turn the medicine on.

At this point, we let Shila go back to sleep. We'll finish up our parts of the operation where we're closing the dura, the covering of the brain. We put back the pieces of the skull bone. We close up the pieces of skull bone. We close up the skin and scalp. And at that point, we're ready to wake up her at the end of surgery.

And it's at that point, again, Wayne, there's a very important difference in the awake craniotomy patients as to how they wake up, versus a typical surgery patient.

What we try to do with these awake craniotomy patients, again, because we're using drugs that wear off really very quickly, it allows us to have a patient who is awake, talking, fully cognizant of their surrounding, and able to do a number of things that they would not ordinarily be able to do if they had a regular general anesthetic. And we're, at this point in time, getting ready to enter the recovery room.

So most patients after surgery, we think of them as being groggy for a period of several hours. That's not true with these patients at all.

No. No.

In fact, you'll note that these patients are so awake that one of the things they can do, as you mentioned, is communicate. And so something that Wayne likes to do is actually have the patient be able to speak to their relatives on the phone immediately at the completion of surgery. I think that's an event that's reassuring for the patient but also for the family.

This is your Aunt Pearl. Is that it?

Yeah.

She's on the phone here. Hang on one second. I'll let you talk to her. Tell her you're okay.

All right, baby.

There you go. Here, put that up to your ear.

I'm fine. Yeah.

Let's get these off.

Yeah. Yeah. Yeah.

Tell them you'll be see them in about an hour.

I'll be able to see you all in about an hour. About an hour I'll be able to see you all. Okay.

Okie doke. I'll come down and talk with you in just a few minutes. Okay? Coming out of the operating room and going to the recovery room and then the neuro intensive care unit is just the first steps. And that's what this is is a journey of many steps, requiring the assistance and the teamwork of an awful lot of people, again, an area where we're very blessed here at our Neuroscience Institute to have a team composed of surgeons; anesthetists; nurses in and out of the operating room, in the UCI; physical therapists; occupational therapists; social workers; nutrition consultants. It's the interplay and interaction of all these people on the team pulling together for the common good that takes what we have done in the operating room and translates that into a patient who can go home in good shape.

So after surgery, because Shila's tumor did have some malignant features, she went on to receive both radiation therapy and some chemotherapy, and she has done very well with those treatments. We continue to see her regularly and to do follow-up scans, and that's how we'll judge what's happening and how this tumor is responding.

And when I went to him for my first visit after surgery, he got me two gift cards to the Roadhouse steakhouse for two steak dinners, and he said, "I told you I'm a man of my word." I said, "I never did not believe you." I said, "I always figured you would do the right thing." I said, "I was just waiting. My mouth was really watering."

I think one of the things that you can see with Shila with her commentary during surgery and then before and after is that she very much wants to live with this tumor, and I think that's an incredibly important concept. I tell patients all the time I don't want them to think they're suffering from or suffering with a tumor. I want them to be living with the tumor, with the emphasis on the living part. Yes, there's a tumor there, and, yes, there may be some limitations posed by that, but life is still there and there's still a lot of it to be had, and I think Shila is a great example of somebody who does that very successfully.

As far as having the awake craniotomy, I would suggest it to everybody because there's less down time. You don't have the groggy feeling. You don't have the yuck feeling. The Methodist University Hospital, the staff, the surgeons, the hospital stay and all was very wonderful. I mean I don't think I could have went anywhere else and had the care and the staff that I had. You know, they were all wonderful to me.

Shila and those like her are the inspiration behind the innovation of the surgeons, anesthesiologists, and staff at Methodist University Hospital. Shila's hope, and ours as wells, is that you find inspiration and courage through her surgery.

To view brain tumor case studies, you can visit our virtual brain tumor board, the largest collection of case studies on the Internet. For more information on the Neuroscience Institute and the brain tumor program at Methodist University Hospital, please visit our neuroscience website.