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ACOUSTIC NEUROMA RESECTION
WAUKESHA MEMORIAL HOSPITAL
WAUKESHA, WISCONSIN
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00:00:08
ANNOUNCER: Welcome to ProHealth Care Waukesha Memorial Hospital. Over the next hour we will present a panel discussion on the surgical resection of an acoustic neuroma. Dr. Steven Harvey and Dr. Kenneth Reichert will discuss their roles in the procedure. Michael McCrea, PhD, Executive Director of ProHealth Care's Neuroscience Center, will moderate. Acoustic neuromas are benign tumors most commonly found on the nerves controlling hearing and balance, located at the heart of the skull. Common symptoms include loss of hearing, loss of balance, or problems with weakness on one side of the face. This particular procedure is so intricate two surgeons are involved.
00:00:48
STEVEN HARVEY, MD: These tumors require the services of both a neurosurgeon who's got training in this area and also a neurootologist. We both have very defined roles that we play in the surgery. We're not assisting each other; we're actually co-surgeons, and we're responsible for different parts of the tumor removal.
00:01:09
ANNOUNCER: Once the tumor has been removed, the chances of recurrence are slim.
00:01:13
KENNETH REICHERT, MD: Surgery for this should offer patients a greater than 99% cure of the tumor.
00:01:19
ANNOUNCER: Viewers are able to email request for appointments and more information by pressing the appropriate buttons on their computer screens.
00:01:30
MICHAEL McCREA, PhD: Hello, and welcome. I'm Dr. Michael McCrea, Executive Director of the Neuroscience Center at ProHealth Care in Wisconsin. On behalf of our panel of esteemed physician experts this afternoon, I want to thank you for joining us for this live webcast focused on the surgical resection of an acoustic neuroma, a procedure that was performed at Waukesha Memorial Hospital. And we are delighted to be joined this afternoon by the two physician surgeon specialists who conducted this procedure and are very experienced in this particular approach to acoustic neuroma. We have with us Dr. Kenneth Reichert, board-certified fellowship-trained neurosurgeon. Dr. Reichert completed his medical school and residency training at the Medical College of Wisconsin before completing multiple fellowships in clinical neurosurgery, including skull-based surgery. Dr. Reichert has been staff neurosurgeon at Waukesha Memorial Hospital for several years, and again, has developed a specialty interest and expertise in acoustic neuroma intervention. Also joining us this afternoon is Dr. Steven Harvey, board-certified and fellowship-trained neurootologist and ENT surgeon. Dr. Harvey completed his medical school training at Creighton University Medical Schools and also completed multiple fellowships following his training. He has also been on staff at Waukesha Memorial Hospital for several years. Gentlemen, thank you for joining us. I thought we could perhaps start with some background on the concept of acoustic neuroma; perhaps a little bit about the epidemiology, or the prevalence of this

condition; signs and symptoms that patients first come across that warrant medical workup and diagnoses; and then talk about your approach to neurosurgical intervention.
00:03:35
KENNETH REICHERT, MD: As you can see from this presentation, about 8% of intercranial tumors involve the middle ear or the inner ear area where these tumors are formed. Although it's not very prevalent per 100,000 people, it constitutes now between 2,000 and 2,500 cases per year. Ninety-five percent of these are just in one side of the brain, although there's a subset of patients that can have tumors on both sides of the brain that have a little bit more problems than the average patient that we see with this type of a tumor. Next slide. This is just a brief anatomy for people that are – have an anatomy background. There are four different segments of tu—of nerve that go into the region where these tumors form. There's a little hook up in the right upper-hand side pulling off one area of the nerve. That's the nerve that moves the face, and that's a nerve that we concentrate an awful lot on preserving during this surgery to maintain the ability to close your eye, the ability to smile. And the other nerves are the nerves of balance and the nerve of hearing, and those are the nerves that are on the lower part of this slide. This is a MRI view of a patient that actually has neurofibromatosis 2, or a genetic type of acoustic neuroma, where you can develop tumors on both sides of the—or both nerves, I should say, on both sides of the brainstem area. In this MRI of the two white tumors in the middle of this MRI show the patient that has a tumor on both sides. I think Dr. Harvey can go over some of the symptoms that patients present with. Dr. Harvey probably sees more patients in presentation, this being more of an ear, nose and throat or a hearing loss problem than other patients that I would see in presentation.
00:05:40
STEVEN HARVEY, MD: First, I'll just start off by saying that the majority of patients that Dr. Reichert and myself see are referred in already with a diagnosis of acoustic neuroma. We don't usually make the diagnosis ourself; they've been sent in to us for treatment. But the two hallmark symptoms of patients who do present with this are a unilateral hearing loss and tinnitus, which is ringing or buzzing in the ear. I become much more concerned in a patient who presents with unilateral symptoms than with bilateral symptoms, as far as working them up for an acoustic neuroma. Now, these patients that present with a hearing loss, it's a sensory neural hearing loss. There are two different types of hearing loss that you can have, and this is a nerve deafness type of hearing loss that these patients present with. The other type of hearing loss that you can have is called a conductive hearing loss, which refers to the eardrum or the bones of hearing, and that's not what we're talking about here. The majority of patients that present with a hearing loss, it's a high-frequency hearing loss on the audiogram, or the hearing test that we do. These tumors will first affect those high-frequency fibers. They may have reasonably good hearing in the low and the mid tones but they'll have a drop off in the high frequencies. Now, as these tumors enlarge, however, obviously they begin to involve more nerve fibers, and you'll start to see the hearing drop off in the low and the mid tones also. The other hallmark that these patients will present with, not just hearing loss but reduced discrimination. In other words, they may come in and say they can hear, but they can't understand what's being said. Somebody can be talking to them. Sure, they can hear them speak, but they don't understand the words or they're more garbled. And there is a test that we do in the office for that called a speech discrimination score, and these tumors will affect that and drop that score considerably.
00:07:35
MICHAEL McCREA, PhD: Just to clarify again for the non-medical viewer today, you used the terms “unilateral” and “bilateral,” and we're referring there to unilateral meaning hearing loss or tinnitus, or rather symptoms occurring on one side of the brain, or in one ear, versus bilateral, meaning in both ears. As I look at the signs and symptoms—and maybe we can fast-forward to the signs also—like in a lot of neurologic conditions, many of these signs and symptoms are non-specific to acoustic neuroma per se, and might reflect other conditions.

Are there – and as I think of the viewer here this afternoon, it may be the case that they're running mentally down that checklist saying, "I have this, I have this, I have this." You referred to hallmarks, but what are really the indicators that you look for as the distinguishing features that point you in the direction of acoustic neuroma, taking into consideration that oftentimes the diagnosis is already made by the time they come to you.
00:08:46
STEVEN HARVEY, MD: Well, as I said, it would be a – if they come in describing a hearing loss in one ear, reduced ability to understand hearing in that ear, also ringing or buzzing noises in that ear alone. If a patient comes in and has an audiogram or a hearing test that shows a high-frequency hearing loss in both ears that's relatively equal, I'm not worried about acoustic neuroma.
00:09:12
KENNETH REICHERT, MD: The hearing test does discriminate a lot of –
00:09:13
MICHAEL McCREA, PhD: The audiogram is really diagnostic.
00:09:16
STEVEN HARVEY, MD: Yes, it's very helpful.
00:09:18
MICHAEL McCREA, PhD: Where does then the imaging piece of it, or radiologic tests such as brain MRI, etc.—how has advancement in neuro-imaging helped you as-as either in a diagnostic sense or in guiding your surgical intervention?
00:09:37
KENNETH REICHERT, MD: Polytomograms, which are just about obsolete at this point except on the neurosurgery boards, of course—got to have four questions on that just to make sure you studied everything you possibly could study to pass this test. But nowadays most all of MRIs are diagnosed with—tumors are diagnosed with MRIs and not CT scans or polytomograms, as they were in the past. MRI provides a very high-definition evaluation of the area of where these tumors come from. CT scan, there's a lot of bone deformity in that area, and you can get some artifact, and smaller tumors could be missed. Because of the MRI imaging, we really can make most diagnoses with this.
00:10:24
STEVEN HARVEY, MD: Another point, too, is with a CT scan, even a good-quality CT scan with contrast can certainly miss a tumor, certainly under 1-1/2 cm in size, whereas an MRI scan will pick up a 3-mm tumor. We've seen an evolution over time also. With use of MRI more and more, we're picking up smaller and smaller tumors. A lot of these patients are being imaged for other reasons, too, such as they come in with a nonspecific headache, dizziness of an unknown etiology. They may not have much of a hearing loss or even be aware of it, and they'll be diagnosed with an acoustic neuroma based on other symptomotology.
00:11:02
MICHAEL McCREA, PhD: So I assume that in the case of acoustic neuroma, it's like any growth of any sort, that the earlier the identification the better, and it allows you to intervene sooner before this generates secondary effects on brain or hearing loss, et cetera. The advances in brain MRI have basically enabled us to identify these tumors before they reach a large size? Is that a fair statement?
00:11:31
STEVEN HARVEY, MD: Correct, absolutely. We've been able to tell with longitudinal studies, with MRI, we can determine somewhat average growth rates. We do know that these tumors don't grow in a linear fashion for every patient either. They may stay stable in size for a period of time, then go through a growth cycle, and then remain stable, so it's not as if they grow in a linear fashion. But on the average, studies will show that these tumors will tend to grow 1 or maybe 2 mm a year. Maybe 10% of patients with these tumors will have what we call a fast growth rate, and that can be up to 10 mm in a year. So if you've got a

patient that you may not be planning any surgical or radiosurgical procedure on, if you first diagnosed them, I invariably will repeat an MRI scan within a year just to make sure I'm not dealing with that small 10% that has a fast growth rate.
00:12:18
MICHAEL McCREA, PhD: Okay. And once this-this tumor identified – that's a term that we've used several times already here in the first several minutes – what is the discussion you generally have with a patient differentiating this acoustic neuroma from, for example, other types of brain tumor or neoplasm, given some of the assumptions they may make about mortality, morbidity, outcome, need for immediate surgery, et cetera, for acoustic neuroma, versus perhaps a meningiome or some other types of tumors.
00:13:05
KENNETH REICHERT, MD: When you look at the slide, what we call the differential diagnosis, which is the working diagnosis or the possible options that we're seeing, or thinking about, at least, when we evaluate this type of a situation, you can see there's about four or five tumors that are available or come to our mind when we look at these MRIs. By far the most common one is the vestibular schwannoma, but the meningioma, which is a tumor of the lining of the brain, an epidermoid, which is a type of a tumor that come either from the skin or from a type of infection, and metastatic diseases, one that we do see in some patients. The other thing that we need to always be aware of when we're evaluating these patients is that the vestibular schwannomas come from only one type of those three different nerve fibers that we—three different nerves that we're evaluating in that area of the middle ear, and that we can also see tumors that come from the movement nerve of the face and potentially also coming from the hearing nerve itself.
00:14:15
MICHAEL McCREA, PhD: We've talked a lot already about a general overview of acoustic neuroma, how prevalent the condition is in the general population, how we go about making a differential diagnosis and determining that indeed this is an acoustic neuroma versus some other condition. Now let's turn to how you go about evaluating what the best treatment option is for this individual patient that's sitting in your office on a given afternoon. What are the treatment options available to you, how do you go about determining whether or not someone is indeed a surgery candidate, how soon they need surgery, and then why don't you tell us about your surgical approach.
00:15:00
KENNETH REICHERT, MD: Well, we're supposed to do this in an hour, Mike, so that may take – hard to narrow that down a little bit. But overall there are really three different approaches that we take for this, the first one being observation. In a patient that's older, is potentially having a fair amount of other medical difficulties that are going on with them, with a small tumor they may have a very mild hearing deficit, observation may be an ideal situation for that patient. As Dr. Harvey said, many of these are very slow-growing tumors and in the elderly population, other mortality rates or mortality factors can be involved in taking care of these patients that a tumor will not have involvement with. Obviously this is a long surgery, there are some complications that go along with the surgery, and that type of patient may not be able to tolerate a 4-, 6-, or a 12-hour procedure, depending on the size of their surgery. Surgery is obviously the option that we do for a majority of patients, but the other surgery, or other type of treatment that's being done, is radiosurgery. Radiosurgery is a focused radiation that is given to the tumor that in initial studies appears to control roughly 85% to 88% of tumors, at least in the initial treatment for it. The big problem with radiosurgery in the long term and for younger patients is that these tumors—a lot of these tumors will continue to grow beyond radiation therapy, it can lead to more difficult problems. Another factor that is not really totally explained or figured out in the literature yet is when we're giving radiation therapy to the younger patients, we're giving them radiation like we do for our cancerous tumors. What are the long-term effects of that going to be for patients 20 and 30 years down the road? We're going to see conversion of a

non-cancerous tumor into a cancerous tumor. So that's part of the education, or discussion, that we have to have to them is to—at least the three different pathways that they can choose when having these tumors treated. In an older patient that has a bigger tumor that has other medical issues or a life expectancy that may be less than somebody in their earlier ages, radio radiation therapy or radiosurgery is becoming a valid treatment option for. Still, in the younger patient I think surgery is the best treatment option for the majority of patients.
00:17:47
STEVEN HARVEY, MD: I would agree with that. The three things that I look at with a patient, and Ken does too, is age of the patient, size of the tumor, and their overall health. A younger patient, radiosurgery you've got to follow those patients lifelong, and if that tumor does grow later on in life and requires surgical resection, the surgery becomes technically much more difficult, too. You're working around scar tissues within an irradiated area, your preservation rates for hearing certainly drop off, and they also do for facial nerve preservation, too. So that's another discussion that I have with younger patients especially who may be considering radiosurgery.
00:18:28
MICHAEL McCREA, PhD: Can you two perhaps both comment on how your innovative approach to this condition, acoustic neuroma, developed and your partnership. To me it seems like an incredible advantage to the patient to have both a neurootologist and neurosurgeon not only consulting on the case but actively involved in the operating room, handling the complexities of this from each of your given specialties. Can you give us a little bit of background on how your partnership developed over the years?
00:19:04
KENNETH REICHERT, MD: Dr. Harvey and I's relationship started when we were younger, so to speak – and I still consider myself young at times. We started working together in Milwaukee and developed a relationship there. We both were two fellowship-trained surgeons that were out in our community, and we still are the only surgical team in Wisconsin where we are both fellowship-trained in doing these-these procedures. There are a couple other teams in Wisconsin that do treat these tumors, but either one or both are not fellowship-trained, so that we provide extra training, extra education, extra experience to being able to treat these from different backgrounds, too. I trained in Cincinnati and Dr. Harvey in the Chicago area, where a lot of tumors were being done, and it gave us more experience in being able to really bring this technology to the area here.
00:20:16
STEVEN HARVEY, MD: I guess I'd just emphasize that we don't assist each other in surgery; we are co-surgeons. We each are responsible for a particular part of the operation ourself. It's really too small of an area to have four hands in there. So it's a tag-team approach, but we very much are responsible for different parts of the procedure.
00:20:36
MICHAEL McCREA, PhD: Well, today we have one case that we'd like to focus on. And what I was thinking is perhaps you could walk us – we could begin to walk through a little bit of the background on this particular patient, how this acoustic neuroma was initially uncovered diagnostically, and then you could show us in real-time, so to speak, the procedure itself and we can talk a little bit about how it played out in this individual case, and then perhaps a little bit about your outcomes from the case series of these procedures.
00:21:08
STEVEN HARVEY, MD: This gentleman that we're going to be showing here is, I believe, a 37-year-old gentleman. Interestingly, he actually presented with somewhat different symptoms than the average patient. His major complaint was facial numbness on that side of his face that had been present for some time, and he had undergone a CT scan of his sinuses at some point and did have some sinus disease and actually underwent sinus surgery, thinking that that may have been part of the cause of his facial numbness. It did

not resolve after that. He actually has a significant hearing loss in that ear but was only subjectively aware of a mild loss. When we did an audiogram, he had basically a nonfunctional hearing ear on that side. He underwent an MRI scan farther up in the states and was at that point known to have a large acoustic neuroma with significant brainstem compression.
00:22:07
MICHAEL McCREA, PhD: So this is someone from outside our normal region who sought out the two of you because of your experience base, or perhaps his primary care physician was aware of your expertise and sent the patient your direction?
00:22:20
KENNETH REICHERT, MD: Well, he was sent to our surgical team. For this type of a procedure, the patient—the tumor is coming from where the ear nerves enter into the brain. And on this slide you can get a rough idea of the approach of where we're going with this. The patient is typically on their side with the affected ear, or the involved ear, up. The hole is made behind the ear where the circle is drawn on this—on this hologram, so to speak. And in the middle of that circle, that darker area or that dark spot, is a patient with a smaller tumor than the one that we're going to be doing today. This gives a basic anatomy of what we're going to be looking at when we're in there. To the left-hand side are retractors that are moving part of the brain— balancing, so to speak—or the movement coordination center, called the cerebellum. To the right-hand side of the slide is where the nerves come from the middle ear into the brainstem. And right in the center, the round mass in the middle of that is where the tumor is actually involved.
00:23:38
STEVEN HARVEY, MD: I'd just like to comment, too, that this particular approach is known as a suboccipital, or the retrosigmoid approach, which we commonly use for larger tumors. It gives us better access intro the brain area. There are two other approaches that can be used also for surgical removal. One of them is where you come in above the ear—and this one obviously we're coming in from behind—but if you come in from above, that's known as a middle fossa approach, and we do that strictly for smaller tumors where we're trying to preserve hearing. Tumors that extend beyond the bony channel into the brainstem area, those patients are not usually a candidate for that approach. The other approach is where we go directly through the inner ear. We come a little bit farther forward than what the diagram here shows and we actually drill and open right into the inner ear to get to these nerves. That approach can be used for smaller or larger tumors, but by definition you sacrifice whatever residual hearing is present because you've opened up into the inner ear. So if you've got a patient who doesn't have serviceable hearing to begin with, you can use that approach. Although for this patient here, he had a very large tumor, and that's why we chose the retrosigmoid approach, because we have better access to the brainstem.
00:24:59
MICHAEL McCREA, PhD: I assume that in this particular case it was the size of the tumor that produced an effect on a cranial nerve other than the auditory nerve that presented with the facial numbness? Is that a generic description of what was going on in this case?
00:25:18
STEVEN HARVEY, MD: Correct. He had involvement of his facial – or I mean, I'm sorry, his trigeminal nerve, which is the one that provides light touch and feeling to that side of the face, not the nerve of motion, which is the facial nerve.
00:25:30
MICHAEL McCREA, PhD: Okay. Here we're starting to see footage from the live procedure in the O.R., and again, I'm going to turn it over to Dr. Reichard and Dr. Harvey to walk us through what we're actually seeing on screen here.
00:25:43
KENNETH REICHERT, MD: What we're seeing in this procedure is the patient is again on his side. The ear is to the top. The brain cerebellum, or the balance center, is underneath that

gray retractor. And the covering of the brain has been opened up, and kind of the triangle on the top has been reflected up and into the side in order to give us exposure of the area where the tumor is. The white area that you see just where the suction catheter is going into is the lining of the brain, or the dura mater, that gives a protective barrier and surrounds the brain. And the tumor is located – As we continue to go down farther along that pathway, you can see that the brain itself has been covered, or protected. There's kind of a gray or a granular material that we put over the actual brain so that the brain itself does not become dried out. And there's also the white patty that you see in there is another protective barrier called a cottonoid patty. That adds more protection to the brain itself so that brain injury to areas that around where we're working hopefully are reduced. In this view right here you can see the gray retractor in the—about the six o'clock position. Right on top of the gray retractor is the actual tumor. The retractor is pulling the cerebellum or part of the brain out of the way. To the top part of this is the covering of the brain, or the dura mater. And the tumor is basically the yellowest material all in between that area. And what we're going to be doing first with this is identifying the tumor, trying to identify around the corners of it, as to do we or do we not have any of the other nerves coming out of the brainstem that could potentially be damaged. Once we've identified those specific areas, we'll start working on the actual tumor itself, or resecting some of the tumor. And we have various types of techniques for doing that. In the older techniques we used an electrocautery where you could actually go in and with little different types of loops, scoop out or under electric stimulation coagulate, and cut out the tumor. And that works well for some tumors that are in less critical areas of the brain. The big problem with that technique is it creates a lot of energy or heat, and the heat could be damaging to the nerves and to the brainstem in that area. So what we typically do in this area of the brain where there's more potential damage that can occur from disbursement of heat is that we use either ultrasound to give ultrasound waves to break up that tumor into small pieces that can then be suctioned up, or as you can see in this technique here, we're using a cautery that is a very specialized cautery called a bipolar cautery, where only the current passes between the two tips of the instrument on the left-hand side, and it allows us to very precisely control the area of the heat. I've just brought in the ultrasonic aspirator, which is the machine that will give ultrasound waves and breaks up the tumor. And this is a special adaptation of that where it also has suction with it that will give sound waves to that area, break up the tumor, and then there's also a suction that's around the outside of that ultrasound machine that allows us to start resecting the tumor. And so with this technique, the inside of the tumor first is taken out to allow a better view around the tumor edge. In smaller tumors we can usually see in front of and behind the tumor once we've got this—once we've got that anatomy identified. But the first technique, or the usual technique, for all of these tumors is to try to identify all the nerves on the brainstem side and all the nerves on the ear side before the tumor is removed from the other cranial nerves or the nerves that are attached to this tumor. For a larger tumor it's very hard to get on both sides of the tumor, so we typically do with the work inside the tumor. We know that there usually is not a normal nerve running through the inside of the tumor. The tumor usually pushes those nerves out of the way and displaces them or pushes them down and forward so that we—we're going inside of the tumor as we're doing here, we can control the, or reduce the—starting to reduce the size of the tumor without having to have a major difficulty with injury to the brain or to the nerves around it. And then on the left-hand—with the left hand or the instrument on the left side, that is the cautery that is coagulating or stopping the bleeding of any of the little blood vessels as they—as they mass, or the CUSA, the ultrasonic aspirator on the right-hand side is doing is removing, or debulking, as we call it, this type of a tumor.

00:31:10

STEVEN HARVEY, MD: Just as a side comment, one advantage of this type of technique where you're debulking is it allows the actual capsule wall to collapse inward so that you can

mobilize it more easily and then eventually look around the tumor and find the other cranial nerves. Just as another comment, in this particular case, this is a non-hearing preservation procedure. With a tumor of this size you're not going to preserve hearing anyway. He didn't have serviceable hearing to begin with, but we're not concerned ultimately with saving his cochlear nerve in this particular procedure. Usually our hearing preservation rates are better if we're dealing with a tumor that's 1.5 cm or smaller. Between 1.5 and 2 cm it gets kind of iffy. Over 2 cm, again, I'll tell patients that we probably will not preserve their hearing unless we're trying to do some sort of a subtotal resection, say, on an older patient where we're trying to basically debulk the tumor, maybe take it off the brainstem due to compression effects, but we're not necessarily concerned in that case with total tumor removal. Now, in the vast majority of cases we do, total tumor removal is our objective, however, as was in this patient.
00:32:25
MICHAEL McCREA, PhD: So the audiogram is in this sense not only diagnostic but it also guides you as to what's the level of function that you can reasonably expect to salvage, or maintain, as part of the surgical procedure itself?
00:32:39
STEVEN HARVEY, MD: Correct. It helps us also determine which approach to use if we're going to surgically remove the tumor. And again, in some patients they're actually happier having no hearing than having dysfunctional hearing. Patients can be miserable if they've got non-serviceable hearing in an ear and they hear a lot of garbled noise that actually interferes with their ability to hear with the opposite ear. So sometimes those patients are better off with no hearing than with non-serviceable hearing.
00:33:09
MICHAEL McCREA, PhD: Jumping off from your comments a second ago, Dr. Harvey, we saw just a minute ago the various classifications for hearing loss or hearing classification. Here on the screen you're seeing complication rates, I guess, or better put, cranial nerve preservation based on tumor size, comparing the national average versus, I guess, those outcomes from your case series here at Waukesha Memorial Hospital. Can you comment?
00:33:40
STEVEN HARVEY, MD: Correct. Now, here we're talking about facial nerve preservation in this slide rather than hearing preservation, which we were talking about with the previous slide. We have a much better rate of facial nerve preservation than we do hearing preservation. In almost every case we do, we certainly have facial nerve preservation as our goal.
00:34:04
MICHAEL McCREA, PhD: For our viewers, can you give us a reference—our viewers that don't have a metric ruler in front of them—can you give us a reference as to what does 1 cm really mean, what does 2 cm really mean? And perhaps you can reference it in the context of the case that we're viewing here today.
00:34:21
STEVEN HARVEY, MD: Well, 2-1/2 cm is approximately equal to an inch. So if we're looking at a less than a 1-cm tumor, we're looking at one that's less than a ½-inch in size. But remember, we're dealing in a microscopic area here also. Those tumors that are less than a centimeter in size very commonly are located just within the bony channel where these nerves enter into the inner ear, and a tumor of that size is not going to be causing brainstem compression or even touching the brainstem. When you get up to the 2-cm sized tumor, you're touching the brainstem, you may be causing some very mild indentation, but no significant compression.
00:35:04
MICHAEL McCREA, PhD: And you mentioned you're working in a very tight space—let's assume it's roughly a ½-inch size tumor. Can you give us now a reference point as to how

that compares to the density or size of the cranial nerves that are involved in that junction area?
00:35:22
STEVEN HARVEY, MD: Well, the diameter of these cranial nerves is like a pencil lead, just for comparison purposes.
00:35:28
MICHAEL McCREA, PhD: Okay, and we have 12 of them intersecting in that tight space along with your ½-inch tumor.
00:35:34
STEVEN HARVEY, MD: Well, not all 12 of the cranial nerves.
00:35:36
MICHAEL McCREA, PhD: Not in that particular area.
00:35:37
STEVEN HARVEY, MD: Not in that particular area, no, but we are concerned with basically three, and in this particular case with four, at least. We're always concerned with the facial nerve. The other one would be a cochlear, or the hearing nerve. The third would be the vestibular nerve, which is a balance nerve. However, with these tumors that nerve is resected along with the tumor, as they generally arise from the covering sheath of that particular nerve. In this particular patient, the fifth nerve, which is the one that provides touch and feeling to the face, was a nerve that we were very concerned about because of the size of the tumor. With a real large tumor you also can become concerned with the lower cranial nerves, 9 and 10, which have to do with your gag reflex, swallowing ability, and voicebox function.
00:36:29
KENNETH REICHERT, MD: We're getting to—we're at the point now where the tumor has been debulked and we're starting to work on the top part of the tumor where the suction catheter is, which is on the right-hand side, is pulling or moving the tumor back out of the way. And with the left hand, the scissors is cutting the little adhesions between the tumor itself and the nerve of feeling or sensation of the face, called the fifth cranial nerve. And as we mentioned earlier, that this patient presented with a fairly significant numbness or dysfunction of that nerve. And you can see by looking at this particular part of the tape that the tumor itself is crushing that nerve, or pushing that nerve up. On the top part of the slide there's a lining of the brain that comes right down along in a plane and the tumor is pushing that nerve right up into that plane. We're adding now a second retractor system in—or as I call them, they never really retract brain with these, I always try to just protect brain, but the second brain protector is being put into there that gives us a little better view of the fifth nerve, or the facial sensation nerve.
00:37:51
STEVEN HARVEY, MD: I'll just comment, too, that in all of these cases we are doing facial nerve monitoring. We actually have needle electrodes inserted into that side of the face that are attached to a monitoring device that we can continuously monitoring facial nerve function and use an electrical probe to stimulate the tissue around the nerve so that we can specifically delineate the tumor from the nerve. In smaller tumors where you're trying to preserve hearing, you can also do auditory or hearing monitoring at the same time. That wasn't the case in this particular patient, obviously, because of the size of the tumor.
00:38:28
MICHAEL McCREA, PhD: And I assume by doing in vivo monitoring, that allows you to better preserve the cranial nerve that is implicated and have better outcomes?
00:38:38
STEVEN HARVEY, MD: Correct. Absolutely. I think your learning curve is much quicker when you're first starting out if you're able to use these devices. There's a set of instruments that are dissecting, stimulating instruments that you can use to actually dissect the tumor away. At the same time they electrically can monitor the nerve.

00:38:58
MICHAEL McCREA, PhD: I have to ask, and I'm guessing it's on the minds of our viewers this afternoon as well, from the—literally, from the viewpoint of the surgeon, how are you able to tell what you're seeing in which spot and what you're dealing with, with each of your probes there?
00:39:17
KENNETH REICHERT, MD: A lot of it has to do with very thorough knowledge of the anatomy that's normal. And starting in your first semester of medical school when you're doing cadaver dissections through both of us spent a significant amount of time back in the cadaver lab during our fellowships learning normal anatomy in this area. You don't know normal, it's impossible to figure out abnormal and be able to pick out the normal tissues—or the normal structures as you're going through that. So that's how you start out first. Obviously beyond that, then, the microscope has dramatically improved the results of this tumor. Back in the early days of neurosurgery, this tumor carried with it a 95% death rate, or mortality rate, in the average patient. That was done prior to any of the microsurgical techniques. The surgeon would present with a large tumor. Usually they'd have a lot of pressure on the brainstem. The surgeon would go in with his finger and kind of scoop the tumor out. Obviously, with that came a lot of anatomy that was with it. Now with the microscope—we're operating in these 15 to 20 times magnification—it allows us very explicit ability to see exactly what we're looking at. But I always look at videotape of what's going on. You always—you never get a full appreciation of the full three-dimensional stereoscopic imaging that the technology or the microscopes that we have nowadays available to us. It's just very hard to put that even this digital recording of this procedure because it just doesn't give you quite as much feel for what you're doing with it. But it does give you a good representation of what we're going on with this.
00:41:17
MICHAEL McCREA, PhD: I noticed on the latest video footage from just a second ago that you're applying some large paddies, some large gauze. Can you tell us a little bit about what is going on there. It was a pretty dramatic interlude there a second ago, now you see it stained. But can you walk us through exactly what's happening at this point in the procedure?
00:41:40
KENNETH REICHERT, MD: Those paddies, or cottonoids as we call them, are designed to protect the normal areas. We usually dissect an area of either the brainstem or of the cranial nerves. Once we've got the tumor freed up from that area, we want to protect it. We don't want any blood clots to form a little adhesion or stickiness, so we'll typically put a paddy in there that will, number one, it tells us this is where we've been, kind of a marker for where we start off the next time around in that area, and it also allows for protection of it. You can see just right down where the bipolar is now, as you're pulling these—on the right-hand side, that is the tumor, and you're pulling that tumor up. And on the white that you can see just a little bit in there, that is the brainstem itself, an area that you don't want to be doing a lot of retraction on, a lot of manipulation to. Very unforgiving area of the brain and an area that we try to protect very heavily. So we don't even, as we focus an area—focus on another part of the tumor, another area, we don't want to leave that area exposed where we potentially could damage that area as we're bringing instruments in and out of the surgical field. You can see here that the little dissector that we have—the tumor in this area was stuck to the fifth nerve, the sensation nerve, as well as the brainstem. And we've got a little microscopic dissector that is freeing up that area of the tumor from the actual nerves in the brainstem in that particular spot.
00:43:11
MICHAEL McCREA, PhD: And specifically referencing the brainstem, can you put into perspective how high the stakes are here for the viewer, in terms of the basic critical functions of those brainstem structures that you're navigating here in the procedure?

00:43:29
KENNETH REICHERT, MD: This is everything. In this area of the brain is an area called the reticular activating system, which pretty much makes us awake. Alertness and ability to function and communicate. On this patient, there's a significant amount of brainstem compression that he had prior to surgery, and he had a significant amount of problems getting that area working again afterwards. Fortunately, he continues to make an excellent recovery. He's back at work at about 3 months from the resection. But it took a little bit of time and a little bit of the brainstem in that area to get better. All of the movement, or all of at least the control of the movement that our brain has to the rest of our body all passes through that area. And fortunately, this type of tumor does not invade into the brain, but it does press on so that you're able to remove the tumor from the brainstem area, but not always without consequences, especially in bigger tumors. On steadiness of gait or kind of walking like you're drunk, it is a very common side effect that you can see with a significant amount of brainstem problems. Weakness on one side of the body is not an uncommon area either.
00:44:47
MICHAEL McCREA, PhD: I see. My point, I guess, is that the region you're working in in resecting this tumor is not such that the patient is likely to come out with some mild memory loss; this is a region of the brain, the brainstem in particular, that results in really life or death functions: pulmonary functions, breathing, heart rate, as you said, a level of alertness, consciousness, etc.
00:45:10
STEVEN HARVEY, MD: Correct. These are not—this is not an area of the brain that just has to do a higher critical function; it's vital functions.
00:45:20
MICHAEL McCREA, PhD: Yes, good point. Looks like the procedure itself has moved into a little bit of a different stage here. Perhaps you could comment.
00:45:27
KENNETH REICHERT, MD: Well, what we're starting to do now is we're continuing to remove the tumor off of the brainstem. We've cleaned out a lot of the inside of the tumor, which allows us the capsule, or the outer covering of the tumor, we can start closing it in on itself. And as we close in or continue to move or collapse that outer capsule, we're able to get around the tumor and start seeing more and more normal anatomy. And that's really what we're doing at this point right here is we're working to free up the area where the fifth nerve actually attaches to the brainstem. And we've now—we started on the outer part where the nerve, or the sensation nerve of the face was leaving or heading out into the face, and now we're gone to the other side of the tumor where the nerve is leaving the brainstem and heading out into that area and just peeling the tumor and dissecting the tumor off of that facial sensation nerve.
00:46:20
STEVEN HARVEY, MD: Just for the audience's sake, too, this may appear that it's proceeding slowly, but the thing to remember is as these tumors grow, they pick up a blood supply from all the surrounding structures: the lining of the brain, also blood vessels coming off the brainstem, so these blood vessels have to be carefully coagulated before you resect parts of the tumor capsule away. You can't just go in there and start to scoop this tumor out. It has a significant blood supply from surrounding structures.
00:46:49
KENNETH REICHERT, MD: This particular procedure lasted about 12 hours, and although we're not promoting the sleep lab, we didn't want to have anybody have to put -- actually go through the actual 12 hours that we spent with this patient to get this tumor out, so we've reduced some of this, but you can see, as you're looking at this actual procedure that this meticulously small, slow moves that are being made into this area. The actual working field, if you look at it, is about a half of an inch by three-quarters of an inch to an inch or so.

A little bit farther up and down, maybe an inch and a half that we're actually working in that whole field that you're seeing, so it's a very small area that -- that we're working in for significant amounts of time.
00:47:35
MICHAEL McCREA, PhD: You mentioned the concept earlier of the microscope, and I think for most of us, we think of the device on a counter in a laboratory. Tell us -- and tell the viewer that has never been in the O.R. what you're referring to actually in "microscope" and specifically about the instrumentation that you wear and that you utilize throughout procedures like this.
00:48:02
KENNETH REICHERT, MD: Well, it's -- it is basically the same concept that -- that you are -- you think of when you're looking at a microscope under slides and things along that line, other than that it's been placed into a little bit different optics, a little bit different field so that we're able to see magnification -- we usually will go from about two or three to 20 times the normal size, but you also have an ability with this microscope to zoom in and zoom out so we can get up very close and really magnify even more and zoom out and get less of a magnification as we go with that. The microscope also has a focusing button. Certain microscopes will have an ability to move the microscope with the mouth, a mouthpiece that we can just bite down on, we can move the scope around. That allows us to be more efficient with our hands; we're not constantly taking our hands out of the wound, putting our hands back into the wound. It saves time. And as you become a more proficient surgeon, you're able to refine a lot of what we call the micro-surgical techniques that -- that do take time to learn. This is not a skill that you just walk in off the street and say, "I'm going to become a micro-surgeon." Most -- most residencies for this are seven to ten years that you're doing training to learn -- learn these techniques. A lot is done in a laboratory setting, and then -- then you obviously start with simpler procedures and advance your skills as you're able to do that up to these much more technically difficult procedures that are done.
00:49:36
MICHAEL McCREA, PhD: Based on that, maybe this is a good moment where we can walk through -- in addition to the specific case that we're watching here today, perhaps the two of you can comment on the case series that you have under your experience belt here at Waukesha Memorial. I know this is in excess now of several dozen acoustic neuroma patients, I believe, and I know that you've been tracking your surgical outcomes relative to national standards and maybe that's -- maybe this is a good point to comment on the experience base that you've accomplished or accumulated as a -- as a partnership of surgeons.
00:50:17
KENNETH REICHERT, MD: This -- this series, I think, as we've added a few patients since we actually put this PowerPoint presentation together, and I think we're up about 38 to 40 patients now in our series that we've done at Waukesha Memorial Hospital of just vestibular shwannomas. If you look at the other patients that have had skull-based tumors that -- that Dr. Harvey and I have done in other approaches, there's a few other types of tumors that you see going on with this. The -- but by far the bigger -- the bigger percentage that we see with this is these vestibular shwannoma-type tumors, especially in the -- in the brainstem area.
00:50:57
STEVEN HARVEY, MD: Now, in this segment here of the video clip, I've already drilled out the bone of the internal auditory canal, that's the bony channel that I had alluded to earlier where these nerves from the brainstem actually enter into the inner ear in the skull base. We have to drill out that bony channel and identify these nerves within that area because the tumor is also inside that channel itself. The bone has already been drilled away; that's done with a high-speed drill and using what's called suction irrigation, where you're --

actually have a continuous flow of fluid that's also being suctioned at the same time. What it does, it reduces the heat buildup from the drill, which is rotating at approximately 80,000 RPM. So the bone has already been drilled off of the tumor within the channel, and we can see some of the nerves as it's being dissected away from them.
00:51:55
KENNETH REICHERT, MD: What you're seeing here is he's trying to identify just the edges of where the bone is -- stops and the lining or the covering over the nerves begins. And also where the tumor is. The tu-- where the suction is and that catheter is now is all tumor that is from -- that is inside of the -- the beginning of the middle ear where the nerves are heading into that middle-ear region. And he's identifying exactly where that is and now he's starting, with the probe on the right-hand side, he's starting to dissect off the covering over the tumor to try to identify again beyond the tumor to get up to normal areas of nerve.
00:52:33
STEVEN HARVEY, MD: Another point, when you're drilling the bone down in this area, that bone is not solid bone oftentimes; it actually has what are called air cells. It's like a honeycombed system, and you'll open up into these various air cells and when you're done with the procedure, you have to seal those air cells up watertight to prevent spinal fluid from percolating through those and getting into the area behind the eardrum. If that were to happen, then spinal fluid can leak down a channel known as your eustation tube, which opens up in the back of your nose. So potentially you can get a spinal-fluid leak that actually drains out of the nose if you don't seal up all these little air cells that have been drilled away. These air cells are oftentimes at the outer layer of the skull, too, where Dr. Reichert opens up the craniotomy initially. There can be air cells in the bone there, and we have to be very careful and meticulous at the end of the procedure to make sure that those are all sealed.
00:53:30
MICHAEL McCREA, PhD: And at this point in real time, how far into the 12-hour procedure are we?
00:53:38
KENNETH REICHERT, MD: We're probably about seven hours or so into this.
00:53:41
MICHAEL McCREA, PhD: So just past the midway --
00:53:43
KENNETH REICHERT, MD: The midway point. What you're seeing -- seeing here now is that this is the covering, or the dura, over the skull, and what you saw previously, what that scissors was cutting was that piece of covering that was flipped down off of the skull and we're -- Dr. Harvey's now cutting that lining over the top to expose the tumor specifically and not just the covering over the tumor that -- or the canal where this tumor's been growing.
00:54:13
STEVEN HARVEY, MD: That's actually the dura entering into the canal itself that you have to split open in order to access the actual contents within the bony channel.
00:54:25
MICHAEL MCCREA, PHD: You can -- you can see pulsation there in the video. Can you tell us a little bit about the vasculature or the blood vessel system that you have to be acutely aware of in -- in this particular procedure?
00:54:41
KENNETH REICHERT, MD: Well, there -- there are really -- there's one major artery that -- that comes and supplies the -- mostly the cerebellum, called the anterior inferior cerebellar artery. Off of that artery are two separate little microscopic arteries that go in and supply blood supply not only to the nerves in that area but the hearing to that area, too, and those vessels sometimes can come in from the side, they can come in from the top; it's a little bit variable in how they will present themselves to the field, so we have to be conscious of

those vessels, especially in a procedure where we're trying to preserve hearing, that we don't take those little vessels if at all possible. Most of the time with a tumor of this size, the vessels have been pushed down underneath the tumor and are not necessarily right on top where we're going through, so any of the bleeding that you can see going on as this dissection is occurring, typically it's coming just from the lining of the brain or maybe some small vessels that are going and supplying the tumor itself.

00:55:49

STEVEN HARVEY, MD: What I'm doing here is using a special instrument, which is a right-angle nerve hook, to try and separate the dura or that covering that lines the bony channel away from the underlying tumor as we're dissecting here. We're actually going from a medial to a lateral direction, or from inward toward -- working toward the inner ear itself, but again, there's a number of blood vessels that communicate between the dura itself and the tumor capsule, so as you go along, you have to be careful to try and coagulate those to prevent excess bleeding.

00:56:22

MICHAEL McCREA, PhD: Perhaps you could comment to the non-medical viewer in a little greater detail about -- there's obviously the skull as a protective vault for the brain, but this -- this dura matter and the layers of the dura, can you give a sense as to the -- the toughness of that -- of that layer, that blanket that covers the brain? I think a lot of times the perception is that it's just a very thin sheath, and why is it creating so much difficulty to cut through it. Can you comment on the -- the durability of that?

00:56:59

KENNETH REICHERT, MD: Well, in Latin, *dura mater* means "tough mother," so the actual covering over this area is quite thick and, as you can see when you get it -- when you flip it off to the side that it does provide yourself a fair amount of protection to the brain. Obviously, it's not as tough as the skull itself is at protecting the brain, but it does provide another means of protection, especially in -- especially in these areas. It also will have some degree of give to it or expans-- expansibility, but it's not -- it doesn't allow great amounts of expansion to occur, as you can see as you're popping this open. As you start opening this up, the tumor will actually start expanding or pushing out that a little bit outside that area, as Dr. Harvey is meticulously dissecting this whole area out.

00:57:57

STEVEN HARVEY, MD: At this point, just for the audience also, the inner ear has been partially drilled out in this particular case, again, because we're not concerned with preserving hearing, so I will actually drill out until I can identify some of the structures of the inner ear. That way I know that I've completely opened that bony channel out as far as I need to to get the access to the end of the tumor.

00:58:21

KENNETH REICHERT, MD: When we get out to the area where the suction is at this point is about where the usual tumor will end. The suction tip just moved, but right about where that -- where that little metal thing is pointing, so that classically, that area again, we start developing and we can identify normal tissue again, which is, again, paramount that we need to do. As you can see from this point, we've not really resected any tumor yet, mostly because we don't know where the normal structures are. So what he's going to do right now, he's going to work on identifying the normal structures farther out or way up to the left, ten o'clock region of the screen.

00:58:58

STEVEN HARVEY, MD: What these nerves will do out in this area of the channel is they'll begin to actually splay out and they'll enter their own individual little bony channels as they go to the various parts of the inner ear, so it's much easier to identify the individual nerves out laterally in that area rather than toward the brainstem side when you're working inside that channel, so what I'm trying to do is dissect out as far as I can to where I can actually see the nerves begin to separate before I then begin to dissect tumor backward.

00:59:30
MICHAEL McCREA, PhD: And all the while, you're still conducting the intraoperative monitoring of those nerve conductions?
00:59:36
KENNETH REICHERT, MD: That's what you saw right there is -- goes -- that piece that was there is actually the electrode looking for especially that facial movement nerve.
00:59:46
STEVEN HARVEY, MD: This is a set of special scissors here. We've got our own set of instruments here that we use just for these particular cases that are designed for this type of work. We have very small what we call neurectomy scissors and various types of sharp dissectors that are extremely delicate so that we can dissect the tumor away from these nerves.
01:00:05
KENNETH REICHERT, MD: And here Dr. Harvey is starting to cut the -- what we call the lateral, or the tumor that's closer to the nerve part of it. What you can start to see now as he's starting to do that is what we've been waiting for and looking for and meticulously trying to find, are the nerves that are underneath the tumor. You can see those white structures right where that probe is, and this is going in right there, that those are the nerves that we've been trying to preserve through this procedure.
01:00:30
STEVEN HARVEY, MD: The whiter nerve there is the facial nerve to the left of the right-angle hook. The other nerve is the cochlear nerve, which is going to be cut here shortly, I think in this section.
01:00:45
MICHAEL McCREA, PhD: So for our viewer, that again, compares to the thickness of a pencil lead.
01:00:48
STEVEN HARVEY, MD: Correct.
01:00:50
KENNETH REICHERT, MD: In a smaller tumor, that tumor right -- or that nerve right there is another part of our goal of trying to preserve it. A tumor of this size has already completely damaged this nerve beyond repair such that in hopes of trying to, number one, preserve the movement of the face as well as completely resect the tumor, we would take this. In a smaller tumor, we wouldn't be doing this part of the move right here or this part of the procedure.
01:01:16
MICHAEL McCREA, PhD: So in this particular gentleman, he presented with facial numbness but did not have a facial droop or lost motor function of his face, is that correct?
01:01:27
STEVEN HARVEY, MD: Correct. Interestingly enough, the facial nerve is very resistant to pressure from these tumors until they become extremely large. That facial nerve, in this case and with other cases that have large tumors, is stretched out over the dome of that tumor like a transparent ribbon, but yet it still has normal function.
01:01:49
MICHAEL McCREA, PhD: Dr. Harvey, you mentioned moments ago that you had drilled out the inner canal. Can you, for our viewer, comment on that concept of drilling out?
01:02:01
STEVEN HARVEY, MD: Well, again, it's a high-speed pneumatic drill, it's air-driven and a very high RPM, as I mentioned earlier, about 80,000 RPM, and you're basically just drilling the bone away and producing bone dust, and you're using what's called a suction irrigator, which has a flow of liquid that you're directing right on the burr to cool the bone down so that there's not heat transfer into the nerves, and there's also a suction tube attached to it that suctions up that fluid along with the bone dust. We try and keep the bone dust to a

minimum inside the surgical area because studies have shown that if there is residual bone dust left behind, there's an increased incidence of postoperative headache. So we're very meticulous before we do this of putting gel-foam packing Cottonoids in that area also so that that bone dust does not diffuse into the cerebral spinal fluid, that we collect it all back up.
01:03:00
MICHAEL McCREA, PhD: It looks like we're entering another phase of the procedure here where further resection is going on. Can you comment?
01:03:09
KENNETH REICHERT, MD: Well, we've hit the point where tumor from the ear part is meeting the tumor in the brain, and what Dr. Harvey is doing right here is trying to identify right at that crux where the tumor is really pressing on that facial movement nerve, and the nerve will usually take a fairly sharp angle right at -- right at this point here, kind of being pushed away from its normal track, and he's trying to free up just that adhesions or stickiness that the tumor has to the covering over the brain, also trying to identify exactly where is the movement nerve of the face as it's -- as it's transversing or passing through that particular area. You can see when he flips the tumor back that there's a fairly large white structure, or band, that runs in there, and that's really what we're looking for as we're doing this procedure, or this part of it. Again, if we get lost or we're not quite sure where the anatomy is -- obviously, we never get lost in these procedures, but if -- if you're looking for what exactly is normal, what is tumor, and we're not sure exactly where that tumor/nerve interface is, we can go back to our monitoring systems and identify with stimulation of that nerve exactly what part of it -- of the nerve is. It's very common for the nerve right at this point to really be squashed, and it goes from a round nerve and it can be very flattened out and it can be very wide to the point where you can actually see lines through the nerve. Each one of these nerves is made up of little bundles, and if you slowly push those nerves apart, you can actually separate -- we can actually see in between the nerves -- fibers itself, and it's important here to really not lose any of those little fibers, and that's what we're doing right at this point, trying to preserve that particular area of -- of the nerve itself. Very critical area right here. It's a very common area to damage the nerve as you're trying to dissect it free in this area, and it gets back to the concept of a team. And I remember, in my fellowship, my professor always -- Dr. Tu always strongly encouraged the team effect. If you're doing a 12-hour procedure and you're doing it by yourself and you're there for 12 hours, you get to this point of the procedure and you're tired, and you have a tendency to say, "I want to rush this. I want to go on with this." And number one, you got a team member saying, "This is the critical part, take your time. Do this right." And the other factor with it is, is with the team approach, we have a time where this may be my major part of the next four hours is this 20 or 30 minutes of dissection. I can come in and I can really focus on preserving the nerve at that point. There's no rush through this area. There's no damage that's done to the nerve when you're able to really do an expert job by having this team approach to it.
01:06:13
MICHAEL McCREA, PhD: You've just answered one of my key questions that I suspect has been on the minds of our viewers, and that is: in a 12-hour procedure, whether it be acoustic neuroma or otherwise -- and maybe a test of your own reticular activating system -- how do you stay alert, sharp, and -- and given the stakes here, how do you stay that fine-tuned for that long?
01:06:39
KENNETH REICHERT, MD: Well, I'll tell you, as you get -- as you do this more and you become more trained in it, time is irrelevant. And you just kind of go into a zone and you're there, whether it's part of your Chinese medicine training or you really get into that Zen or not, but you really do -- time is irrelevant. I've had cases where I've spent 20 hours straight under a microscope; did not take a bathroom break, did not get up, did not walk around. All

of a sudden you realize a lot of time went by, you know, what's going on at that point? And you get up and maybe you're a little sore, you're a little stiff, but overall when you get to this point, you realize the stakes are high, and your attention span is very -- very focused on that area, and you see the movements and stuff; there's meticulous movements that are going on, and they're very directed, very well planned out before the proc-- movements are done. What exactly I'm going to do. You can see, there's no sharp, fast, jerky motions that are going on in there. This is all design. All motions are made away from the tumor, away from the brainstem. You'll see, there's very -- there's very few strokes that are ever downward on the screen. All the strokes are away from the screen, the brain being on the downward part, the skull being on the upward part. So even there, if something would by chance slip or move, the movement and everything is away from that area. And that's all part of the training that you do as you're learning to take care of these patients is getting yourself in a meticulous way that you do it, and you do it that way. And obviously you change your skills based on what the anatomy of the procedure gives you, but you want to make sure that you're doing the basic techniques that you've been trained throughout your career so that you have better results.
01:08:26
STEVEN HARVEY, MD: I guess I want to comment, too. There's a difference between a team approach and a good working relationship. We have a good working relationship; neither one of us tries to be the hero. If one of us is unsure or suspects something, we'll quickly call the other one in and have him take a look, a second pair of eyes, get a different approach or a different view, or take over for a diff-- particular part of the case. So there is a difference between just working with somebody and having a good working relationship.
01:08:55
MICHAEL McCREA, PhD: Giving the --
01:08:56
KENNETH REICHERT, MD: You've got to be confident with each other, and that's part of what building a team is about. You don't -- you don't -- you know, there are people I've worked with that you just -- you don't have a good relationship, you don't get a good working -- somebody's not part of the team, and this is -- there's no heroes in this one. This is -- this is a both -- this is a combined approach, and that's how you get successful with it. You got somebody doing more than they're capable or going beyond their level of attention or something, problems happen. And the idea of it is to keep your -- your complication rates as low as possible, obviously with, also, having a -- a resection rate that is within national acceptable standards.
01:09:34
MICHAEL McCREA, PhD: Given the incredible complexities of this procedure and the other procedures that the two of you do, it strikes me that -- again, if I'm the affected patient or my family member is affected, expertise and training combined with experience are everything. I'm going to ask the two of you -- Dr. Reichert, you mentioned a second ago, you referenced one of your former professors -- I suspect that during these lengthy procedures, you have a repetitive song that kind of plays in the background; various principles from your prior training and some of your mentorship in the past. Tell us, what is it that you keep hearing from your -- from -- both of you, in your world-class training from your mentors, what is it that's most critical on your mind when you're in there?
01:10:26
KENNETH REICHERT, MD: Well, I think the biggest thing that you -- that you try to do when you're training to do this -- obviously, there's a lot of high tension that goes on in here -- is that you've got to be relaxed. If you're not relaxed, you're not comfortable, you cannot go long periods of time with doing this, so that's always the first thing I -- when I sit down, how am I sitting? Am I rel-- is this chair -- we do this all under a microscope chair. There's a special chair that we have that's all electric: the arms go up and down, that goes backward and forward, I can raise it up and down in the air. You want to get in a good

position that your arms are comfortable and that you're comfortable in doing this. You can't do these for 12 hours if you're not comfortable, and if you're in some cramped, cocked position, you're going to -- you're not going to do a good job. So that's number one. Number two, you want to get a good view of the situation. You want to make sure that you know exactly what you're doing on both ends of the -- of the tumor. And I think that that's -- that part of it is really essential. But even before all that, you've got to be planned. You've got to sit down -- usually the night before, I'm going to sit down, I'm going to go over the patient's history, I'm going to go over the x-rays, and I'm going to review exactly "what am I going to do in that operating room tomorrow? What are my goals? Are we going for a partial resection? Are we going to debulk it? Do we want to remove this tumor? What are his functions? What can we -- what parts of the nerves do we need to preserve on this? Where do I really have to take meticulous time in trying to accomplish those goals?" If you come into it, there are enough psychological studies that say that a successful surgery is 80% preparation. If you know what you're going to do, if you know how you're going to do it, and you go in, 20% of it is actually just doing it.
01:12:04
MICHAEL McCREA, PhD: Dr. Harvey.
01:12:05
STEVEN HARVEY, MD: The one guiding principle that I keep in the back of my mind when I'm operating is: work from the known to the unknown. In other words, don't ever dissect blindly or work blindly. You go from an area of anatomy which you've fully delineated, you know the structures, and then you work from there forward as you further identify structures as you go.
01:12:25
MICHAEL McCREA, PhD: Thank you. Can you bring us back to the video? It looks like we're entering yet another stage of the procedure itself and perhaps winding down in our video footage of the procedure.
01:12:35
KENNETH REICHERT, MD: Yeah, a little bit. The tumor itself has been totally taken out of the middle ear and it's being reflected down more towards the patient's spinal cord or body, and at this point, it's been cleaned off of the movement nerve, and see -- it's hard to see; there's a little bit of blood over the facial movement nerve right now, but that part of the tumor has been flipped out, and at this point Dr. Harvey is starting to figure out those air cells as to where exactly are potential leaks that we're going to be dealing with in this procedure to go. And you can see here that I've -- I've protected the brain with an area -- that little blueness in there is a sealant that we put in that area over the top of the whole thing to try to seal up any potential small, little cells where they are. And here's a little bit of the sealant that we put over the -- over that area to protect that or to seal up the skull base from -- from having any spinal fluid leakage, and we can talk a little bit about that afterwards. This is a newer sealant that's actually been approved for covering or performing -- covering of the dura or that protective layer that we talked about earlier. The trick to this right now is this is a kind of a glue and it'll stick to everything, and you've got to now dissect the protective barriers that we have off of this without pulling the whole -- the whole sealant or the whole glob that we put in there out. And also breaking it. Kind of -- it flows in as a liquid and then it forms. We want to try to keep all the little microscopic little pores that it's filling in -- we want to try to keep those all sealed to try to prevent the patient from developing a spinal-fluid leakage into the middle ear and into their nose, as we talked about earlier.
01:14:19
MICHAEL McCREA, PhD: Could you -- go ahead, Dr. Harvey, I'm sorry.
01:14:21
STEVEN HARVEY, MD: Just one thing I was going to mention that we didn't earlier. Before the case in almost all of these cases, Dr. Reichert will put a lumbar drain into the patients

where there's a spinal catheter that actually enters their lower back, and we drain spinal fluid off during the procedure that way to help reduce intracranial pressure, slack in the brain so to speak, so that we're not putting as much pressure on the brainstem when we're working. And those catheters we'll typically leave in for several days postoperatively to help take pressure off that area and reduce the chance of a spinal-fluid leak through the surgical site.
01:14:55
KENNETH REICHERT, MD: Similar to the Hoover Dam when they built the diverting -- diverting channel around the dam to allow that area to dry, allow the -- the dam to dry, and then once that area's sealed in three or four days, that allows us then the ability to be able to -- to put pressure, put force of the normal spinal fluid onto that area. And here we are just kind of cleaning up -- cleaning up the area, as you can see. You can see the lower area, the lower part, four or five o'clock is the brain cerebellum, and you can see that that's pulsating well, and as we're irrigating, it's starting to fill or come back in to its normal position, covering up or going into that area as we go.
01:15:33
MICHAEL McCREA, PhD: Can you put into perspective for us -- it looks as though the excruciating detail work is complete now, the tumor is resected -- tell us about closing the case.
01:15:46
KENNETH REICHERT, MD: Well, closing is -- the main goal of closing, obviously, is to give the brain a protective barrier, try to re-- reconstruct the anatomy. And then also we -- we usually will kind of tag-team that again with each other, looking at each layer of closure to make sure that we've sealed up all the holes, especially in the bone so that we're not having a spinal-fluid leakage difficulty.
01:16:10
MICHAEL McCREA, PhD: We've spent some time this afternoon talking about the critical outcomes. In terms of the surgical outcomes, there are very minute cranial nerves that affect my facial function, my -- my hearing, my other neurologic functions. We've also detailed on screen I think here your outcomes relative to the national average, and I -- I can't help but notice that your outcomes are superior to what is documented in other surgical centers across the country, and I think that's a credit to your training and experience, and we can continue to reference that on screen, but -- and I -- I'm a strong believer that, as I'm looking for a specialist, I want to know that information. I want to know how good are they, but I also want to know -- in this particular case or in your case series -- what can patients expect as a good outcome?
01:17:09
STEVEN HARVEY, MD: Well, I always tell patients first off that you're going to be in the hospital for approximately a week afterwards. You're off work oftentimes after surgery for four to six weeks, sometimes a little bit longer. Just the fact of having a craniotomy is fatiguing. These patients do have, you know, some malaise. They're fatigued even when they go back to work. For several months, they oftentimes will notice that they're worn out at the end of the day. So I kind of prepare them for that before surgery. So even though they're out of the hospital within a week, that doesn't mean they're recovered and back to work that quick.
01:17:47
MICHAEL McCREA, PhD: Sure, it's an extensive procedure. Their brain has been opened up. One of the questions I'm sure many patients have is, is this going to grow back?
01:17:57
STEVEN HARVEY, MD: Well, we do have a protocol for following these patients, also. Standard procedure, approximately six months after surgery, we'll do a baseline MRI scan. Now, oftentimes we'll see various areas light up just from post-surgical changes. Then the next time we do an MRI is approximately -- I'll do one about two years after surgery and

then one about five years after and then approximately 10 years after. So I do tell patients that we do monitor them with MRI scans. Luckily, we have not had anyone with a recurrence to date. Not that that can't happen, but --
01:18:35
KENNETH REICHERT, MD: We're young guys. I'm obviously a little younger-looking than him, but we're actually the same age, but I agree that the -- the recurrence rate for us so far has been zero, and in large series, especially in the microscopic era, we don't expect this tumor to recur in patients. Obviously, you can leave a small amount at one end or the other that potentially could grow back, but the other thing that we do in the operating room to try to prevent that is that we usually will biopsy the nerve. We think it's clean; we'll usually send a small bit of that nerve tip or end to make sure that in fact we really do have clean margins as we call it in the operating room.
01:19:15
STEVEN HARVEY, MD: Just to clarify that, it's not the facial nerve that we send a piece of, it's the vestibular or the hearing nerve where the tumor has dissected away from.
01:19:22
MICHAEL McCREA, PhD: Sure.
KENNETH REICHERT, MD: Tumor nerve.
01:19:24
MICHAEL McCREA, PhD: Are there risk factors? For example, if I have a first-degree relative or family member with an acoustic neuroma, am I at increased risk of the same or --
01:19:34
STEVEN HARVEY, MD: Generally not. As Dr. Reichert mentioned earlier, these are unilateral in 95% of cases. The inherited disorder, neurofiber mitosis, is autosomal dominant inherited, so certainly family members with that have to be monitored. But in general, patients who have a unilateral acoustic neuroma, their other family members are not at any significant increased risk of having a tumor also.
01:20:03
MICHAEL McCREA, PhD: That's a common question, and any form of tumor is --
01:20:07
KENNETH REICHERT, MD: "What is my risk? What is my risk as a family member?"
01:20:09
MICHAEL McCREA, PhD: Yeah, for the family member that's sitting in the exam room, "Am I -- do I go to bed tonight wondering if I'm at increased risk?" And I guess the answer is no in this case.
01:20:16
STEVEN HARVEY, MD: These patients will also ask what's the risk of them subsequently developing a tumor on the opposite side, and if they don't have neurofiber mitosis, I tell them they have the same risk of developing it on the opposite side that I do.
01:20:28
MICHAEL McCREA, PhD: If I'm watching today's webcast or -- or -- and experiencing what I think might be the signs and symptoms of an acoustic neuroma or one of my family members may be, what do I do first?
01:20:44
STEVEN HARVEY, MD: I would first recommend a hearing test, an audiogram. That's the -- usually the first step in the workup of these patients. If a patient has a hearing loss in one ear, especially in the high tones, I generally do work that up further. Now, I also have patients who may have normal hearing or symmetric hearing, but if they come in and consistently complain of having tinnitus or ringing only in one ear, I may image those patients also. Some of these smaller tumors, believe it or not, they won't have any hearing loss on that side or their hearing loss will be symmetric.
01:21:24

KENNETH REICHERT, MD: Most of those -- most of those evaluations, workup, can be done in your ear, nose, and throat physician's office. Most of them will have some degree of an audiologist, and that test is readily available in most communities. A lot -- a lot of the referrals that we do get, as we mentioned earlier, come from our hardworking force of ear, nose, and throat general -- general ENT surgeons, if you want to call them that. Obviously, all of them are sub-specialized and have extra training in what they do, but Dr. Harvey is -- kind of gets most of his referral base and most of our referral base actually comes from ear, nose, and throat surgeons that do a lot of these screening and evaluations with us.
01:22:05
MICHAEL McCREA, PhD: Let's -- myself and the audience alike, let's capitalize on the fact that we have expertise from both sides of the -- of the O.R. table, so to speak, here, neurosurgery and neurootology. If you could each take maybe a minute or two and provide the audience with what you think are perhaps the most important take-home messages related to this procedure, this condition, et cetera. Or recapping our discussion throughout the day.
01:22:37
STEVEN HARVEY, MD: Well, first off, I would start by saying get as much information as you can if you've been diagnosed with one of these tumors. You need to be aware of all the treatment options that are available and the pros and cons of each of these. Again, it's an extensive discussion that we have with patients regarding their treatment options. What may be an excellent option for one patient at the same age and size of tumor may not be what another patient would optimally be dealt with. So I think they need to know the pros and cons of all that. Most of these patients that do come in have already been on the internet and come in with a fair amount of information to begin with. They have a lot of questions, and unfortunately a lot of the information on the internet is exaggerated or false, but most of them have already researched it before they come in.
01:23:26
KENNETH REICHERT, MD: And we do sometimes -- we'll direct them into better spots where they can get information at least that we feel is reliable and available to them. As Dr. Harvey said, there isn't a right answer for everybody that's easy to come to, but there's always an answer that people usually, once they've got a good, informed consent, so to speak, or conformed -- informed evaluation of what their options are, will come to the conclusion of which is the best treatment option available for them, whether it be observation, surgery, or radiation therapy.
01:24:03
MICHAEL McCREA, PhD: Thank you. Any other additional comments?
01:24:07
STEVEN HARVEY, MD: The other thing that I'll mention to patients is that they don't have to make a decision right then and there when they're in the office as far as their treatment goes. The vast majority of these, again, are slow-growing tumors, they're benign, they're not cancerous. They can take some time making a decision regarding what treatment option is best for them. Occasionally, yes, we do have a patient that come in, such as this one, with an extensive, large tumor who may be at risk for brainstem herniation or hydrocephalus or other neurological complications that does need to be dealt with fairly quickly, but the majority of patients that come in with a small or medium-size tumor, they have the luxury of a little bit of time to make an informed decision.
01:24:48
KENNETH REICHERT, MD: And anybody that tells them different, we obviously see some of the competition's tumors, too, and some of them are, "You're going to die if you don't have this tumor taken out immediately." That's classically not the case with this type of a tumor. Obviously, there's a lot of anxiety that goes with the diagnosis of having a brain tumor, but part of it is -- this is a tumor you're going to live with a long time -- and the results of it and the effects of it, you're going to live with a long time. You need to come in and make sure

you've done your research, that you've got the best team available for you to help you make the most informed decision, and not somebody that's going to lead you down a pathway that may be most convenient for that particular surgeon or team.
01:25:26
MICHAEL MCCREA, PHD: I could not agree more. I'm going to perhaps wrap things up here this afternoon. I want to personally thank Dr. Reichert and Dr. Harvey for what has been a completely fascinating hour or so for me, and I'm sure the same for our audience, not only providing us with a general overview of what is a generally rare condition, acoustic neuroma, but also I guess for directly illustrating to us on film from a live procedure just how delicate and intricate this procedure is when -- and perhaps more than any -- where expertise, training, and experience is everything. That -- that I've known about the two of you for a long time, and I think -- I think now most of the state and perhaps most of the Midwest is beginning to know that, too, based on the case series that you have accumulated here at Waukesha Memorial Hospital. But what also strikes me is your approach to the patient, and not necessarily charging in to every case recommending that surgery is the only option or a rapid option but conveying confidence to the patient and the family member. As you mentioned, when there's a diagnosis of a tumor of any sort, I think our minds start to race as to what -- what could the inevitable be here, and to have confidence in your physician in that moment, or your family member's physician, is everything. So we are very fortunate here at ProHealth Care in Waukesha Memorial Hospital to have a team of experts that you two make up, and I've been so impressed for years, and I think our community and now the state of Wisconsin and really the region is to thank for your partnership, too. So I want to thank you for joining us this afternoon. I also want to thank our audience for -- for being with us here. If you have questions, you can certainly contact the ProHealth Care Neuroscience Center. That information is available, I believe, on the web site, and we can get you in touch with both Dr. Reichert and Dr. Harvey. Thank you for joining us.
01:27:33
KENNETH REICHERT, MD: Thank you for having us.
STEVEN HARVEY, MD: Thank you.
01:27:38
ANNOUNCER: Thank you for watching this panel discussion of an acoustic neuroma procedure, presented by ProHealth Care Waukesha Memorial Hospital. To obtain more information, to make an appointment, or make a referral, please click the appropriate buttons on your screen. ProHealth Care: We're here for life.
01:28:07
[end of program]