TRANSNASAL ENDOSCOPIC SURGERY FOR SKULL-BASE TUMOR
SENTARA NORFOLK GENERAL HOSPITAL
SENTARA, VA
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00:00:10
ANNOUNCER: Welcome to Sentara Norfolk General Hospital. In just moments, you'll see transnasal endoscopic surgery for skull-base tumors. This innovative surgical procedure uses the nose as a natural orifice to remove skull-base tumors. It's brain surgery without the surgical incisions required to remove the tumor through the face or skull. The minimally invasive technique allows patients a quicker recovery with less blood loss than traditional brain surgery. OR-Live makes it easy for you to learn more. Just click on the "Request Information" button on your webcast screen and open the door to informed medical care. Now let's join the doctors.
00:00:58
JOSEPH L. KOEN, MD: Good afternoon. My name is Joe Koen. I am a neurosurgeon with Neurosurgical Specialist here in Norfolk, Virginia. Today we are at Sentara Norfolk General Hospital, and we are in the middle of a live endoscopic pituitary tumor surgery. I'm joined by my colleagues Dr. Joseph Han, who is an ENT physician at Eastern Virginia Medial School, as well as Dr. Vijai Singh, who is a neurosurgeon with Neurosurgical Associates. Dr. Han and Dr. Singh will be performing the surgery and I will be explaining things as we go through. First, a few words about Sentara Healthcare. As you can see on the slide, Sentara Healthcare is a not-for-profit healthcare system, been in business for 118 years. They have seven local hospitals, seven nursing facilities, and over a 300-member physician medical group. The service area is quite large. Sentara serves a large area in southeastern Virginia as well as northeastern North Carolina. So today we are doing a transnasal endoscopic surgery for skull-base tumors. Again, my colleagues, Dr. Joseph Han, an otolaryngologist, or ENT, physician, head and neck surgeon at Eastern Virginia Medical School. As well as Dr. Vijai Singh, who is a neurosurgeon with Neurosurgical Associates here in Norfolk and Virginia Beach. Myself, Joe Koen, I am a neurosurgeon as well with Neurosurgical Specialist based here in Norfolk, Virginia. The pituitary tumor surgery historically has been done using both specialties, ENT and neurosurgery. The ENT physician is largely responsible for the approach up to the skull base into the tumor. Once the tumor is reached, the neurosurgeon dissects and removes the tumor, and then we turn it back over to the ENT physician for closure. A -- I could remind the viewers that you are able to submit questions to us via the e-mail. Just click the button on your screen if you like. If we go back to the slides here, we'll talk about our patient history for a few moments. Our patient today is a 71-year-old male. He does have a history of hypertension, diabetes, high cholesterol, and anemia. He's had previous cardiac surgery and carotid artery surgery as well. He had presented some time ago with headache and visual lost. The patient went to his ophthalmologist, who documented loss of visual fields, loss of visual acuity, and he astutely ordered an MRI scan of the brain. Now, this study showed us a very large pituitary tumor about 6x5x3 centimeters, about the size of a small lemon. His hormone levels were normal. At this point I'd like to say just a few

words about the pituitary gland in general. You may have heard the pituitary described as the master gland of the human body, and that's a very good name for it. It does control all of the bodily hormones, hormones such as your thyroid, the thyroid gland, cortisol, the adrenal gland. It also influences the kidney with urine output and so forth. It's responsible for prolactin, for lactation, growth hormone, other hormones like testosterone, estrogen. So it's a very, very important gland, and certainly we see tumors here. Tumors that present in and around the pituitary comprise about 10% of all brain tumors that come to clinical attention. The way that pituitary tumors typically present is with headache and visual loss. And we'll see sort of how that works in a few moments. If we can go to the screen here, you'll see our patient's MRI scan. There are two MRIs. Our patient today has the MRI scan here on the left. This is what's called a coronal view, looking straight on. The brain here is this gray structure, these black structures are the ventricles, very normal-looking. The tumor is this entire white area that extends up deep into the brain and comes all the way down here to the skull base, as I'm outlining here for you. Now on the normal MRI scan on the right side, you can just make out the optic chiasm, or the optic nerves, that come from the eyes and of course enable vision. So you can see as a tumor grows up, this tumor especially is severely impinging the optic apparatus and the optic nerves. This view is a side view, or what we call a sagittal view. This is another MRI scan image, and again, our -- the tumor is in this area, goes all the way up towards the third ventricle and the hypothalamus and all the way down here to this area to the skull base. The pituitary gland, and therefore pituitary tumors in this area, sit in a very small, very confined area. The upper border is really bordered by the optic nerves, the brain stem is right here just behind the tumor, and on either side we have the carotid arteries. I can go back and just show you that here. On the normal, this black structure is the carotid artery actually on the left, and here's the carotid artery on the right, and the normal pituitary sits here. So it's a very narrow, very deep corridor in which to operate. The patient presented elsewhere and had a standard transseptal transshpenoidal approach, which is the typical way to do this operation using a microscope. It is through the nose as well, but a retractor is used. And a subtotal resection was done and some tumor was left. The patient had nasal splints and nasal packing for about five days, which is the routine for the traditional approach. At that point, after the initial surgery, the patient was informed that there was residual tumor and a craniotomy was suggested, which is operating through the top of the skull to come in from the top to remove the tumor. At that point, he wanted a second opinion and was referred to our skull-base team. The next slide describes what we're doing today, okay? This is today's procedure. It's a transnasal endoscopic pituitary tumor resection or removal. It is a minimally invasive technique, and I'd like to say just a few words about the definition of minimally invasive. It is a very common term these days, minimally invasive techniques are becoming more and more common, more and more applied in different areas of surgery, and neurosurgery, nasal surgeries, is no exception. I think there are a few principles that are important. With a minimally invasive technique, there is less disruption of tissues. It keeps anatomy close to normal on the way in and on the way out. Typically smaller incisions are used. And it often utilizes natural corridors for access. And today, we are using the nose or the nasal cavity. We are using an endoscope today, and you'll see that. I think you saw just a bit of it in the introduction, but the endoscope is a long, slender surgical instrument that has a camera inside, and we can pass that directly into the nose, directly up to the skull base, and have a very wide, panoramic view of this very narrow, very confined area. It can give us very good panoramic exposure. It allows us to look around corners. The traditional microscope actually has blind spots, and quite frankly there are areas that you just can't see with a traditional microscope in which tumor could be left. So the

endoscope is quite an advantage. The next slide talks about some of the advantages of the endoscopic minimally invasive approach. The incision is deep in the nasal cavity, there's no incision on the outside of the nose or in the nostril. There's no incision under the lip, which is a typical way to go with the traditional surgery. There's no incision on the scalp. There's no retractor. And many studies, including one we've recently gone through, many studies indicate that there's less postoperative pain, less blood loss, shorter hospital stay. And so with that introduction, perhaps we could go live to the O.R. and check in with Dr. Singh and Dr. Han. How's it going in there?
00:11:02
JOSEPH K. HAN, MD: Hey, Joe, how's it going? Thanks for the introduction. So what we did now -- what we've done so far is we've taken out the -- so sorry, Vijai, I'm going to go ahead and pull back just a little bit. So what we did is we went through the nose and we made an opening. And so since this was a revision procedure, we had to go back and try to find out what they had done previously. And so after cleaning up -- after cleaning up some of the bone graft that they had put in, we've now taken that all out and now we're going into -- what we're seeing is the pituitary tumor. And so we're starting to take that out. Vijai, do you want to say anything?
00:11:51
RAN VIJAI SINGH, MD: Yeah, it's just a redo procedure, so it's very, very adherent to the surrounding tissues. So we are trying to establish a plane here.
00:12:09
JOSEPH K. HAN, MD: And so with any kind of -- any kind of tumor resection or cancer resection, what's important is tissue plane. And you want to try and find out what is normal and what is abnormal. And usually between what's normal --
00:12:21
RAN VIJAI SINGH, MD: That's all tumor, whatever you're getting, so save that for the specimen. Yeah, can I have the curette to the right again?
00:12:29
JOSEPH K. HAN, MD: So what you want to try to find is what's normal and what's abnormal. And what's great about the endoscope is that it gives you a magnified view, you're able to see the normal tumor or cancer interface. And so here we're actually working in the cavernous sinus right here. And we're working off on the side. So there's tumor eviding into the cavernous sinus, as you guys saw on the MRI, and we're trying to pull that out. And you know, as you saw on the MRI, this is a pretty big pituitary tumor which went past this normal cavity and it started going into the brain and went up pretty high. And normally this would be very hard to approach through the nose traditionally, but with the use of the endoscope, we're able to push the boundaries and go back further.
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JOSEPH L. KOEN, MD: So, Joe, tell us there, you're already into the tumor cavity, is that right? There was some fat packing, I believe.
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RAN VIJAI SINGH, MD: -- establish where I am again. The -- is off again. Okay, so... I'm at the interior-most part there.
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JOSEPH L. KOEN, MD: So what Dr. Singh is using here is a surgical navigation probe. We'll show some other pictures of that here in a moment.
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RAN VIJAI SINGH, MD: So that's the back of the thing. I want to see whether I'm in the --
00:14:19

JOSEPH K. HAN, MD: If you can show the image guidance picture, can we get a picture of that, using the stealth? Okay. Okay, Allison, can you show us the -- how this isn't a regular image guidance system, it's -- we're using a CT and MRI together, and we've fused it together so we can get a better look at the tumor, and so, Allison, can you show what it looks like with just the CAT scan? And so that's what it looks like with the CAT scan, and you have a hard time telling where the tumor is at. But if we turn on the MRI, and we're going to start blending that in, now the tumor is clear. And Allison, can you do that again and show us where the -- with the pointer, show us where the tumor is at? Right there. And so you couldn't see that before, but with an MRI fused in with a CAT scan, you can see that much better. Joe, can you see that okay?
00:15:16
JOSEPH L. KOEN, MD: Yeah, that comes across pretty well. And that's a nice innovation to use a CT plus an MRI, because the CT can show us the bony anatomy, which -- which is critical for skull-base surgery. And of course the MRI shows the tumor very well and the other structures like carotid artery and optic nerves. So that's a good demonstration of that.
00:15:41
JOSEPH K. HAN, MD: And so -- so basically that image guidance system kind of acts like a GPS system. It tells us where the tumor is, it tells us where the carotid artery is, where the optic, where the eye nerve is, because you don't want to injure those structures, and those structures are very close to where the tumor is at. And so having this image guidance system, it makes the operation safer. Technically, we haven't been able to show that because the risk of the surgery is pretty low, so you would need a large patient population to be able to show that, but theoretically, it probably -- people have guessed that it's about -- makes the surgery about 10 times safer with this technology than without.
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JOSEPH L. KOEN, MD: Now, Vijai, can you tell us what you're doing there?
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JOSEPH K. HAN, MD: So here what we're doing is -- so we're heading towards the intersphenoid sinus septum, and that's -- the tumor had eroded in the sella cavity, went through the intersinus septum, and you can see, that's some of the bleeding from the cavernous sinus as well as from the tumor, and so we want to try to -- try to control that and get better exposure. So right what we're doing now is, as with any kind of surgery, you want to have a great exposure. And so -- so we're going to try to -- we're trying to ex-- trying to take down the bony partition which separates us from the tumor and we're going to try to slow down the bleeding as well. And we're using --
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RAN VIJAI SINGH, MD: Up by half.
00:17:28
JOSEPH K. HAN, MD: And so you can see the carotid artery right there, there's the eye nerve off to the side. And I don't have a pointer to show, but off to the right upper and left upper corner, you can see the carotid artery and the eye nerve right there. And you can see what's above us is what we call the roof of the sphenoid sinus, or the planum.
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JOSEPH L. KOEN, MD: Dr. Han, we have a good demonstration of that on some prerecorded video. Maybe we can queue the first and second roll and hold it on pause for just a minute.
00:18:07
RAN VIJAI SINGH, MD: I want that curette to the left.

00:18:10
JOSEPH K. HAN, MD: Okay, that sounds great.
00:18:12
JOSEPH L. KOEN, MD: All right. I just -- one question before we go to the prerecorded video. The fat graft that was there has obviously been removed and you're working in the tumor and working on exposure, so that looks -- that looks great.
00:18:29
JOSEPH K. HAN, MD: So, yes, we did take out the fat graft that was there, and there was actually a couple of bony and cartilaginous graft, and so -- and so --
00:18:41
JOSEPH L. KOEN, MD: Joe, we're going to cut away and show the first prerecorded area to kind of show how -- how you got to this point.
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JOSEPH K. HAN, MD: Okay.
00:18:53
JOSEPH L. KOEN, MD: And we can roll that when it's ready. This is from a previous surgery we had a few weeks ago, and this is sort of the beginning part of the procedure, entering the nasal cavity. And here we are sort of navigating back there. There are the turbinate structures that come toward the midline, we can mobilize those over. And this procedure here that we're looking at now from a few weeks ago, it was a redo procedure as well. And those are always a bit more challenging because of the scar tissue and some of the normal landmarks are no longer there. and our surgical navigation systems and image guidance become even more important in these situations. So here at this point we've reached the -- the floor of the skull base, and right now we are probing to try to figure out where is the safe entry point. You can see on the -- we're pointing there with the suction device, the reddish area in the upper right and the upper left are the carotid arteries. And we have to work underneath and between the carotid arteries for obvious reasons. Now this is the same surgical probe that you just saw Dr. Singh and Dr. Han using. We're using it here to find the midline and it's a little bit to the right of midline here, a little bit to the left of midline, and the midline is typically the -- the critical area that we look for because that usually is the safe zone to begin the exposure. And again, upper left, upper right are the carotid arteries, the reddish areas that you see. And the optic nerve, we're going to point those out. It's the opticocarotid recess right there. And if you look closely here, you can see the artery pulsating. If you look very, very closely, and it's a good demonstration of that. So that's the one on the left and then here's the one on the right. And so we've defined our anatomy there, we know where to enter, and we can queue up the second and the third roll-in, and while we do that, I may just remind folks that you are able to submit questions to us. Just click on the button on your screen. And again, if you're just joining us, we're live at Sentara Norfolk General Hospital in the midst of a minimally invasive endoscopic pituitary surgery.
00:22:02
JOSEPH K. HAN, MD: So that's that. Here's the artery right there.
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JOSEPH L. KOEN, MD: So maybe what we'll do, guys -- okay, let's go to the second roll-in here and we'll show what we've already done today. Here's a -- this is a diamond-bit drill. The drill bit's actually coated with some fine diamond -- diamond chips or diamond shavings. And here we are drilling at the skull base layer by layer, millimeter by millimeter.
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JOSEPH K. HAN, MD: Where's the other bipolar? Where's the other bipolar?

00:22:43
JOSEPH L. KOEN, MD: And so this is fairly meticulous work, as you might imagine, especially with a redo case, and image guidance is indispensable. We'll talk about that in a little more detail a bit later, but another advantage of image guidance is it's just used with a preoperative MRI and a preoperative CAT scan. Traditionally, we've used x-ray, you know, intraoperative fluoroscope, so we take several x-rays throughout the procedure to localize our instruments and to tell where we are in relation to the skull base and where we are in relation to the tumor, so using the image guidance has the advantage of completely eliminating radiation, so there's no radiation exposure for our patients or the O.R. team. So we've fast-forwarded here a bit, and here we're using a rongeur to -- to thin the bone here and to expose the covering of the tumor. And again, this is a prerecorded video and we are approaching the point at which the live surgery is. And you can see that we have exposed the covering of the tumor there. And we can go back to the O.R. here and see how we're doing. Again, it's a redo, so it's a lot of meticulous dissection, working through the scar tissue. Looks like Dr. Singh is using a ring curette, which is a common instrument to use to remove the tumor.
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JOSEPH K. HAN, MD: So for revision cases, it's not as easy. You -- you lose a tissue plane between what's normal and abnormal, and so that's -- so we're trying to define our boundaries of where we need to dissect. And so here -- here we see a little bony ledge of bone getting in our way, so again, we're trying to get better exposure to where we're trying to operate around. And so you can see that that's where the carotid -- you see that lower V right there is where the carotid is at, and that's where you don't want to go. And so what you want to do first, and it may be counterintuitive, is to try to find out what's the most dangerous part, identify those areas first, and then you know that everything around the structures is safe. So now that you've identified what's most dangerous, you know what is not dangerous, and so you can work in that area confidently, knowing that you won't injure anything severe. And so this is some general oozing, and some of the -- and this is actually some of the osteitic bone from the tumor, and so you can see we're taking it out. And that's part of the -- the anterior wall of the pituitary, where the pituitary gland sits, and so we're taking that out so we can see that -- we can see that back better. And so now you can see the tumor a little bit better, and --
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JOSEPH L. KOEN, MD: Now, does the tumor look fairly typical to you there in the live situation? It's normally very soft and pliable, is that what it looks like to you there?
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JOSEPH K. HAN, MD: That's right, Joe. Joe, this is not your typical pituitary case. Your pituitary case is very easy, you can find the tissue planes really easy, you can find the tumor very easily, but here with the revision surgery, it's harder to find the tissue planes as clearly. The tumor kind of looks soft, kind of -- kind of grainy. Soft, grainy feel. And -- and I know with the untrained eye, this looks very tough to tell you where you're at, but we know exactly where we're at. And with the assistance of the image guidance, we can confirm that what we know is right. And the image guidance system should never be used to tell you where you're at, because if you're that reliant on the image guidance, then you have a lot of problems. So --
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JOSEPH L. KOEN, MD: We have received a few questions here via e-mail. So we could go through some of those.
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JOSEPH K. HAN, MD: So did you hear that, what Vijai's saying?
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JOSEPH L. KOEN, MD: You're in the cavernous sinus?
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JOSEPH K. HAN, MD: So yeah, so that was a carotid artery that we had just identified, and we're seeing the cavernous sinus. So you were saying that there were some questions?
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JOSEPH L. KOEN, MD: Yeah, we have a few questions.
00:28:01
JOSEPH K. HAN, MD: Are you not able to hear us, Vijai? [laughs]
00:28:05
JOSEPH L. KOEN, MD: Vijai can't hear us, I don't know. He's working there. They're in the cavernous sinus, and as you saw on the MRI scans, that's on either side, on the right and the left.
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JOSEPH K. HAN, MD: Yeah, you see that? You see this stuff, that's the tumor.
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JOSEPH L. KOEN, MD: Yeah, that's very typical-looking tumor for a pituitary adenoma. Very soft, tends to be a bit oozy, fairly routine appearance of that. And the cavernous sinus is a very difficult place to operate in. That's where the carotid artery lies and other cranial nerves that also go to the eye, and you can work there, being very careful, and one of our questions here is: is this tumor malignant or benign? This is a benign tumor, as are the vast majority of pituitary tumors. They -- the most common type of tumor is an adenoma, which is a tumor of the normal pituitary cells that just grows out of control. And we'll have a slide here in a little bit detailing that, so this is a benign tumor. You can see a malignant or a cancerous tumor, that can occur in the pituitary with much less frequency. You can see here more tumor is being resected with the up-going curette. And it's coming out very well. It really comes out piecemeal. And so as you can see here, there's really no retractor. It's just the endoscope and then the surgical instruments that are passed through the nasal cavity. So that's a good demonstration of that.
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JOSEPH K. HAN, MD: Yeah, and so I think you're absolutely right, Joe, is the majority of the pituitary mass is -- or tumors -- most of the pituitary tumors end up being -- most of the pituitary masses end up being tumors, and rarely are they cancerous. And I think it's less than -- it's like 1-4% of that ends up being cancerous. And most of the pituitary tumors, like you were saying, are non-- are non-secreting tumors, like you were saying, the macroadenomas, non-adenomas. And the next most common are the tumors that secrete prolactin, right? Is that right, Joe?
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JOSEPH L. KOEN, MD: I think that's right. If we want to go back to the slide here, we have a little summary of that. So skull-base tumors in general, whereas today we are talking about pituitary tumors, the nonsecretory adenoma, as the name implies, is a tumor that does not secrete any particular hormone or directly influence any particular hormone level, so those -- those tumors typically grow to a very large size oftentimes before they come to clinical attention. And again, the most common symptoms are loss of vision and perhaps headache or pressure behind the eyes. And the optometrist or ophthalmologist certainly can do a nice job of figuring out the typical pattern of visual loss. If a pituitary tumor is secreting a hormone, you can end up with conditions like Cushing's disease, which you may have heard of. That produces a hormone that increases the amount of cortisol in the body. Prolactinoma is another type of secreting pituitary tumor. Acromegaly has to do with the growth hormone. Oftentimes the secreting tumors can present at a much smaller size and

the abnormality is discovered -- discovered on blood tests. We -- we have listed here some other tumors that can occur as well.
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RAN VIJAI SINGH, MD: That's the upper part of the clivus and we can see the dura --
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JOSEPH L. KOEN, MD: Maybe we can go back to the video. So could you explain to us again what we're seeing there, Vijai?
00:33:02
RAN VIJAI SINGH, MD: Yeah, this is -- this is clivus here, and if you see, the tumor has eroded this part of the bone and the tumor was lying here, so I've gone all the way back. And you can see the dura here, and this is the dura. Just behind this is a basilar artery. So we've gotten the tumor all the way in the back, and now we're trying to dissect tumor on the side to get again into the area of the cavernous sinus.
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JOSEPH K. HAN, MD: And you can see some of the tumor right there, laterally.
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RAN VIJAI SINGH, MD: To the left side. The bigger one to the left. And now the other direction. The other direction. Great, thank you.
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JOSEPH L. KOEN, MD: Now is that the diaphragm we're seeing there or is that just more tumor? Probably more tumor.
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RAN VIJAI SINGH, MD: That's clival dura. Yeah, the diaphragm is further in the front here. And you can see that the tumor is tucked up in underneath here.
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JOSEPH L. KOEN, MD: He's taking that out from the left side and --
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RAN VIJAI SINGH, MD: Can I have the other sucker now, please? The double suction -- put a sucker and a trap on that.
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JOSEPH L. KOEN, MD: So if that's the clival dura, the tumor had eroded through the sellar bone?
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RAN VIJAI SINGH, MD: Yes.
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JOSEPH L. KOEN, MD: Okay.
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RAN VIJAI SINGH, MD: So the whole of the dorsum sella is eroded and the tumor has gone almost back to the -- through the bone into this area.
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JOSEPH L. KOEN, MD: That is a very extensive tumor. Again, it is about the size of a small lemon, only 6 centimeters by 5 centimeters by 3 centimeters, and so we're working just in front of the brain stem here. If you remember the previous MRI, we are just millimeters in front of that at this point. Some fairly typical oozing. As far as volume, it's really not very much. But again, this is a revision case. And more challenging.
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RAN VIJAI SINGH, MD: Pituitary, please.
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JOSEPH L. KOEN, MD: So that's, of course, just a pituitary rongeur, or a grasping instrument, to remove tissue. That's a suction -- suction tubing that you see there now. It's starting to look very clean back there.
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RAN VIJAI SINGH, MD: So I'm going to put some Floseal here to try to control this venous oozing from the side here and then come back and remove the rest.
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JOSEPH K. HAN, MD: So I'm worried about up there --
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RAN VIJAI SINGH, MD: Yeah, it's --
00:36:45
JOSEPH K. HAN, MD: Maybe we can get that with the bipolar.
00:36:48
JOSEPH L. KOEN, MD: Vijai, are you able to hear me?
00:36:49
RAN VIJAI SINGH, MD: Yes, I can.
00:36:50
JOSEPH L. KOEN, MD: Okay, the -- has any of the more superior tumor started to deliver itself down into the field yet?
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RAN VIJAI SINGH, MD: No, I can see the hole into the diaphragma and I still have to work that out, so we still have not managed to get that part there, so I'm just going to start working on that. Can I have a piece of -- I mean, with the epi, please?
00:37:18
JOSEPH L. KOEN, MD: It looks like you're making very nice progress there, and again, with these cases, you just have to go step-by-step. It's very meticulous, and another question we had was: was the approach through the previous surgical path with the septum displaced laterally? Well, the -- with the endoscope, you can just go straight back through the nostril without displacing the septum. And that's just one of the advantages. You know, you keep tissues more normal, which is one of the basic goals of surgery, I would say.
00:38:09
JOSEPH K. HAN, MD: You're moving the whole -- that whole wall, Vijai. Moving the whole wall along the -- yeah.
00:38:19
RAN VIJAI SINGH, MD: Yeah, that's -- you'd want -- sometimes the tumor actually works and dissects the plane for you, and here you can see the bone is so thinned out that I'm just able to lift with my curette here that part of the bone, so…
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JOSEPH L. KOEN, MD: Now, how lateral are you right there? Are we looking at tumor or is that getting toward cavernous sinus?
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RAN VIJAI SINGH, MD: We are looking at the part of the tumor here, and the carotid is right -- sitting right here underneath this area.
00:39:01
JOSEPH K. HAN, MD: You want to try to control the oozing with bipolar right there?
00:39:07
RAN VIJAI SINGH, MD: It's the bleeding from the tumor, so --
00:39:09
JOSEPH K. HAN, MD: No, no, it's up higher -- higher up in the dura right there. Yeah, uh-huh.
00:39:14
JOSEPH L. KOEN, MD: So as you hear Dr. Singh and Dr. Han discussing it, that's really one of the advantage-- advantages of working together. You have, you know, basically a running commentary, both the neurosurgeon and the ENT surgeon can comment and think of different things at different times, and it's really a teamwork approach. And it works very well.

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JOSEPH K. HAN, MD: It's just right there, uh-huh.
00:39:52
JOSEPH L. KOEN, MD: Another question we have while -- while we're working there is: what tissues do you have to cut so that you can reach the brain? Well, really, with the endoscopic procedure, we go all the way to the back of the nose and make an incision there, and then we go through what's called the sphenoid sinus, which is just a bony cavity. And then once we're through that, you're basically at the floor of the sella. The sella is the bony area that contains the pituitary gland and therefore contains the tumor. Now in this particular case, the tumor was so large that it had eroded that bone, and as you saw a little bit earlier, becomes paper-thin sometimes and then can be easily sort of chipped away. Maybe we'll go back to the slides here for a moment and finish talking about skull-base tumors. We talked about the pituitary tumors. Most commonly, they are tumors that do not secrete hormones, and they can again, grow to a large size. Other tumors that can be seen in this area, meningioma, chordoma, craniopharyngioma, and other tumors that are listed there can be seen. Other skull-base tumors can occur elsewhere, like vestibular schwannoma. Now, our surgical technique, and you've seen a lot of this already, is the surgical navigation. The access is directly through the nasal cavity, we use only the endoscope for visualization, and right now Dr. Han is holding the endoscope and navigating it in the proper manner and Dr. Singh is able to operate with both hands, or using bi-manual maneuvers. And you can see sort of the teamwork approach here and the setup, and the entire surgery is done looking at the monitor screen. So we don't -- we're not looking through a microscope, but we have the wider panoramic view of the endoscope to our advantage.
00:42:18
JOSEPH K. HAN, MD: And you know, one of the things that used to be said about the endoscopes was that, you know, when you had a microscope, you usually had two views, or what we call binocular view. And because of that, you would have a form of depth perception. But with the endoscope, you don't have that binocular view, it's a minocular view because you're looking through one scope. But -- and because of that, a lot of people were worried that you weren't able to get the depth perception or see how far the tumor or how far the -- the different anatomic structures were. But with what we call dynamic scoping, you know, pushing in and out with the scope and looking around the corners, you're able to kind of tell -- you kind of develop what we call a pseudo depth perception. So you kind of have an idea of how deep things are. Another feedback that we get is the tactile sensation. So when you're using these endoscopes and tools, you're able to kind of feel how far deep -- how deep things are in comparison to your other structures, so with those two feedbacks, you're able to overcome that -- that depth perception that you lose and create what we call pseudo depth perception. And then in -- I guess in reference to the other question that they asked about the septum being displaced, normally the septum is displaced. In this patient, what they did was they actually took out the cartilage and septum and used that to repair the surgical defect. And so in this patient, the bone was actually gone, or part of the bone and septum was gone. And so -- so because the part of the bone and cartilage were gone, it was difficult to find the exact -- it was difficult to find your orientation because when you have a normal anatomy, you're able to kind of define where you're at pretty easily, but all of a sudden when you lose your anatomy and you're doing a revision case, it makes it that much harder to find what is, again, normal.
00:44:41
JOSEPH L. KOEN, MD: Right. Right, those are good points. We have lots of questions here, very good questions. One here is: in which circumstance is the transnasal

approach not used? Well, I'd have to say that for the vast majority of pituitary tumors or tumors in this area, they can be done transnasal endoscopically. As Joe was talking about earlier, this tumor does expand quite a ways upward into the brain, but with the endoscope, we can see that. I think it would be the more rare tumor that is really a giant tumor, and we've seen some of those, that might necessitate a craniotomy or going through the skull, especially if there's very, very lateral extension into the middle fascia or the temporal lobe. What do you think about that, Joe or Vijai?
00:45:51
JOSEPH K. HAN, MD: Is that part of the -- is that dura, the diaphragm right now?
00:45:53
RAN VIJAI SINGH, MD: No. That's the tumor going down.
00:45:55
JOSEPH L. KOEN, MD: I think they're involved there with something.
00:45:59
JOSEPH K. HAN, MD: I think -- I think, Joe, you're absolutely right. I think when you're -- I think, you know, just because we have an endoscope doesn't mean the endoscope is the answer to everything. I don't think that's right. I think there are certain tumors that are much better approached through the traditional method, and that's where you have to kind of rely on the positions you're seeing to make that judgment on what is the best way to approach patients. And to say that this endoscopic approach is not invasive is untrue. I think overall, there is less pain, there is less bleeding, and you do have a shorter hospital stay, but I mean, as a rhinologist, I think it's very invasive for the nose. I mean, you have a lot of scar tissue, you get a lot of -- there's, I think -- you can have bleeding afterwards, and those are -- and you can even get sinus infection. The risk of developing a sinus infection is about anywhere from 1-15% of patients who undergo these procedures, and I think if you do it transnasally, you're more likely to get that, unless it's appropriately taken care of during the time of the surgery to prevent that from recurring. And so I think -- you know, it really depends on the type of tumor it is and where it's located. If it's close to the nose, I think those are the ones that is really best approached through this trans-- through the nose. And such as the pituitary tumor or olfactory or smelling nerve cancer. Those are easily approached through the nose. Sometimes you can have, like, meningiomas, which are also tumors, around this area that you can approach, but some meningiomas are not readily accessible through this approach, so I think those are not -- so I think it really depends on where the tumor is at or where the cancer is at.
00:48:08
RAN VIJAI SINGH, MD: So if you can see here, anteriorly you can see this part here, which is shiny and pulsating here, that's the diaphragma here anteriorly. That's the anterior limit and this is the area of the anterior intercavernous sinus. And it is right here in this area that the tumor is going through the diaphragma higher up. So you can still see the tumor there. And we're going to try to get in there and --
00:48:49
JOSEPH L. KOEN, MD: All right, so that would represent the upper portion of the tumor that we saw in the MRI. And we -- we have one question about potential CSF leak, or cerebrospinal fluid, and yes, that certainly is a risk. I think if the tumor does grow through the diaphragm, it's perhaps already made that very thin layer somewhat incompetent, and sometimes you have to open it to remove the tumor. And we'll see how it goes here.
00:49:21
JOSEPH K. HAN, MD: Libby, can you see what's going on? Right there, thank you.
00:49:24

RAN VIJAI SINGH, MD: Okay. So are you -- if you see on the screen, on the stealth screen, you can see that I'm through the diaphragma and I'm at the upper limit of the tumor.
00:49:40
JOSEPH K. HAN, MD: Can you -- yeah, thank you.
00:49:41
RAN VIJAI SINGH, MD: See how -- if I pull out, you can see that I come down, and as I'm going to the diaphragma, I go all the way up there. So that's the upper extent of the tumor there. Can I have a small curette, please?
00:49:57
JOSEPH K. HAN, MD: So that way it kind of helps us confirm that -- we kind of knew that that was the upper extent of it, and that image guidance was used there to kind of help confirm what we suspected.
00:50:08
JOSEPH L. KOEN, MD: That's really a great demonstration of that, and the procedure, one question is how long does it take? And in general, it can take around two hours. Sometimes less, sometimes more. You can see more of the tumor being delivered there. That looks good.
00:50:28
JOSEPH K. HAN, MD: And you know, on the study that we did, you know, it was about two hours in general to do the procedure, and actually half that time was used to set up for the surgery. And so and if you were to cut from skin to -- and closing the skin, it would almost be a little bit over an hour on average. But obviously with this tumor, it's going to take more than an hour because this is very extensive.
00:50:56
JOSEPH L. KOEN, MD: Right, right.
00:50:58
JOSEPH K. HAN, MD: And you know, that question about the CSF leak, that's actually a pretty interesting question, because you know, most people don't realize that when you have pituitary tumor, it's within the two layers of the dura or the covering -- the lining that covers the brain. And because if you just take out the pituitary gland, regular pituitary glands, you're not going to get any brain fluid leak, and that's why the risk of a brain fluid leak is actually very low. And then -- and so -- and so -- so -- but for something like this, where you have to go past the second layer of the brain, you're going to get a brain fluid leak. And that's why when you're operating, you've got to not operate -- hey, Vijai, that's the optic chiasm right there. You don't think that's the -- you don't think that's the --
Okay. And so that's why, you know, when you're doing the surgery, it's not just important to decide how you're going to get there but also as you're doing the surgery, you're also trying to decide how you're going to repair the surgical defect afterwards. And so you always have to be very conscientious of not just approaching it, taking it out, but how do you repair it so that they heal well and not have the brain fluid leak?
00:52:24
JOSEPH L. KOEN, MD: Right.
00:52:27
JOSEPH K. HAN, MD: So there's some of the tumor.
00:52:31
JOSEPH L. KOEN, MD: It's starting to be delivered there very nicely, it looks like. You mentioned a study we did, maybe we'll go back to the slides and then come back to the O.R. in just a few minutes. The -- we've talked about much of this. This is a demonstration of the image guidance. The tumor is highlighted in green and you can plan different trajectories to it if you like. The trajectory that we're using is basically

here along the arrow, straight through the nose, and this is a previous patient that we had. Similar pituitary tumor going up into the optic nerve. Some of the -- we'll talk about some of the surgical advancements we're now able to offer our patients right here in our region. We've incorporated the endoscope since 1999 and have done this surgery purely endoscopically since 2007. And I think that just shows the evolution of the technique. There is a bit of a learning curve using the endoscope and a certain level of expertise is required. And there are other applications for the endoscope, other intracranial problems: brain cysts, it can be used as an adjunct to other tumor surgery or aneurysm surgery, hydrocephalus, and some other indications. Very quickly we'll go through a couple of slides. A study that we've done here locally. The first transsphenoidal approach was done back in 1907. The first time an endoscope was used was quite a while ago, 1963. But of course as the technology has improved, the visualization has become much better. This study compared the traditional endoscopic -- or the traditional microscopic transseptal approach with the newer endoscopic approach. Those are the two groups that we looked at. The demographics were very similar in both groups, tumor size and so forth. We had about 20 patients in the endoscopic group, 30 patients in the traditional surgery group, and some patients were excluded because they did not have postoperative imaging. And the numbers of the tumor type compared equally between the two groups. The -- you can see some of the results here under the endoscopic. The mean operating time was a little under two hours, which was less than the traditional. The setup time was about the same. We did find that there was less blood loss. The pain score was less in the endoscopic group as well as having a shorter hospital stay. There were really no differences in complications, just as safe as the traditional approach. So we found that there was a shorter operative time, less bleeding during the operation, less pain after the surgery, and the hospital stay was almost -- was almost cut in half. We talked a little bit about the two surgeons working together, and you're getting a sense of how that goes. It's a little give and take and a combination of efforts. Dr. Han mentioned some of these issues with the endoscope, the tactile feedback and so forth. Some people may say it's a disadvantage. You have to learn how to work together. But really, I would look at that as an advantage. There is some loss of depth perception, but with dynamic scoping, like was mentioned, tactile feedback, that is a learned skill, and you can easily tell the depth of the exposure. So in conclusion, four salient points really: shorter operative time with the endoscopic procedure, we found that there was less bleeding, less postoperative pain, and less time in the hospital. It was almost cut in half. There's no nasal packing and so forth. And perhaps we can go back to the O.R. here for just a moment.

00:57:25

JOSEPH K. HAN, MD: So we're using an angled scope. We're using an angled scope, and with that you're able to kind of look -- so here, you're able to change the way you look at things. So here we're looking to the side. Here we're looking up to the high -- and that's because we're looking up high through that diaphragm to get -- and actually you can kind of turn it off to the side as well. So with these angled scopes, you're able to look around the corners without having to really be around the corner. And so -- so since we're going superiorly and trying to get that tumor out through that small opening where the tumor went, we're going to -- that's why we're using this angled scope right now.

00:58:13

RAN VIJAI SINGH, MD: Can I have some, Ron, suckers? Are they flexible, Ron?

00:58:26

JOSEPH L. KOEN, MD: We -- we had another question about the diaphragm, or diaphragma, as Dr. Singh was commenting. And that's really just a very thin layer

that kind of goes around the pituitary stalk and separates the -- the brain area or the intracranial space from the pituitary gland. And I believe we see that now down in the field.
00:59:01
RAN VIJAI SINGH, MD: Have you got enough tissue for this?
00:59:13
JOSEPH L. KOEN, MD: There was a question about do we replace the bone? Do one of you two want to answer that question?
00:59:20
JOSEPH K. HAN, MD: Yeah. I would say it depends on where the tumor is and how big of a surgical defect we make. And so if it's very large and you're worried that the brain will collapse into the nose, yes, we do put in a bone graft or artificial bone graft. If it's small enough where you're confident that the tumor or the brain will stay at its location with the soft tissue support, then we don't need to use -- then we don't need to use any bony graft or artificial bony graft.
01:00:05
JOSEPH L. KOEN, MD: Right. right.
01:00:08
JOSEPH K. HAN, MD: So you can still -- you can see a little bit more of the tumor is going past that, and I'm going to try to get it all out. I don't know if -- yeah, I think -- I don't know -- I think I would just cut that, Vijai, and -- yeah, I mean…
01:00:31
JOSEPH L. KOEN, MD: Some portions of the tumor can be more fibrous than other portions. And that can take a little longer to remove little by little.
01:00:45
JOSEPH K. HAN, MD: So you can see that there's brain fluid leak now, and so -- so in the blood, you can see there's a mixture of brain fluid and blood.
01:00:55
JOSEPH L. KOEN, MD: Right, Joe, and I'd have to say, that's really basically expected, wouldn't you say, with a tumor like this, and if you're going to go after the tumor and go for a complete resection, you know, you're pretty much going to get a CSF leak and maybe you could just talk for a minute about how we patch that up at the end of the case.
01:01:15
JOSEPH K. HAN, MD: Yeah, so that's -- that's right. And so this -- yeah, actually, the brain fluid leak, the tumor actually caused the brain fluid leak because the tumor extended from the -- from the normal cavity that it sits into the -- it went through the diaphragm and it actually caused the brain fluid leak, and so we're just following the tumor, and so you can see that. And because of that, you have to make sure that you close the connection between the nodes and where the tumor is at. And -- and we do that by trying to basically reconstruct the same structure that was there beforehand. So we try to reconstruct the artificial -- we try to reconstruct the layer of the bone -- layer of the brain covering -- and you try to patch everything up with glue. And that's how we normally do it, and then we usually put dissolvable packings to make sure that -- that, you know, the packing is dissolved. And it's so small, the amount of dissolvable packing that we put in is so small that the patient usually even doesn't know that they even have a dissolvable packing in there, and the only way to really see it is through the endoscope in the office.
01:02:35
JOSEPH L. KOEN, MD: And you mentioned the glue. Of course, oftentimes that is fibrin glue. There are some other commercially available products that are used as sealants in and around the brain as well. So you can see they're really getting quite deep in there, and I think getting out the last portions of the tumor that were

extending up high toward the third ventricle and significantly compressing the optic nerve, you can see how that upper portion now, Vijai has to keep that elevated while he removes the tumor. And typical-looking tumor there. And again, there's no retractor. It's all just with the endoscope and the surgical instruments. And of course we send the specimen to pathology, and they do the detailed studies on it and give us exactly the type and subtype of tumor that it is.
01:03:48
JOSEPH K. HAN, MD: Do you want me to retract that tissue just a little bit, that soft tissue just a little bit so you can see a little bit better into there?
01:03:57
JOSEPH L. KOEN, MD: You can see in the bottom right there the fluid issuing out, and again, the tumor basically created that opening because it grew through it. Very, very nice.
01:04:33
JOSEPH K. HAN, MD: Vijai, do you want me to help kind of retract that a little bit, so that --
01:04:35
RAN VIJAI SINGH, MD: Yeah, thank you.
JOSEPH K. HAN, MD: Yeah, this stuff? Yeah. Can we get, like, a pen field, or --
01:04:40
RAN VIJAI SINGH, MD: No, I'm actually -- this thing here?
01:04:43
JOSEPH K. HAN, MD: No, no, in the front.
01:04:45
RAN VIJAI SINGH, MD: The front is diaphragma here.
01:04:46
JOSEPH K. HAN, MD: Yeah, do you want me to -- should I do diaphragma so you can see a little bit better in there?
01:04:51
RAN VIJAI SINGH, MD: I'm retracting that with my sucker here.
JOSEPH K. HAN, MD: Okay, all right.
01:04:57
JOSEPH L. KOEN, MD: So now you see the very thin veil there behind --
01:05:01
RAN VIJAI SINGH, MD: Exactly. You can see that that's --
01:05:03
JOSEPH L. KOEN, MD: Tell us -- tell us what we would see if we would open this.
01:05:06
RAN VIJAI SINGH, MD: The pulsating thing that you see is the very thin layer of membrane that covers the brain. It's called arachnoid. That's covering the posterior part of the tumor here. So we're getting a pretty good pulsation here, but that's always suggestive of -- that we've got a good tumor removal there, so we're going to try to work out and try to get that all the way down here. You can see that bulging in the area of the operation. You see the pulsations here, those are the pulsations for the CSF. And there's still some tumor remaining here anteriorly, and we're going to get to that.
01:06:01
JOSEPH L. KOEN, MD: So that's about the last area, I believe, where tumor is left, the area where he's working now. Everything else looks very nice and very clean. And if we were to open that thin membrane, we might see the optic nerves, we might see branches of the anterior cerebral artery, and that would be inside the subarachnoid space proper. Very good pulsations. That's what you want to see toward the end of the procedure.

01:06:37
RAN VIJAI SINGH, MD: I want to have the curved one there. Yeah, that one there. Yes.
01:06:59
JOSEPH L. KOEN, MD: So again, it looks like Joe's advancing the endoscope closer so we can get a very nice magnified view in this area. And toward the end, you can put it in even further. A large portion. And again, some portions of the tumor can be a bit more firm or fibrous than other portions. And again, this is the portion of the tumor that we saw on the MRI that was pushing up very, very high into the brain, into the third ventricle area, toward the hypothalamus, which connects to the pituitary gland. And it seems to be just a little bit more to do. While we're looking there, we do have another question, more of a technical question: would a transnasal endoscopic surgery be an option for a neurocytoma tumor located near the thalamus and the third ventricle in the brain? It's a possibility. Of course, I think we'd have to look at the particular MRI scan. It would depend largely and very particularly on the exact location. Now, we also do endoscopic surgery through the cranium or the top of the skull for tumors that might be in the ventricle or intraventricular tumors. Sometimes that is an option, and so of course it's a very considered, detailed decision if we could do that. Largely -- largely, again, dependent on the exact location. Moving some more tumor there. We have lots of good questions today. Another one: does this procedure work well with tumors that are around the internal carotid artery closer to the skull? Well, as I -- hopefully you saw there, we had visualization of the carotid arteries, and this particular tumor is near the carotid artery, but again, it's all about location. Some tumors have to be approached intracranially via a craniotomy procedure. And you know, those decisions are made by detailed review of the MRI scan. Well, guys, I'm not -- I'm not seeing a lot of tumor left there. It's looking very good. But what does it really look like from your vantage point there?
01:11:18
RAN VIJAI SINGH, MD: I think we got a pretty good portion of the tumor. There is still some tumor left we are able to get internally. You can still... And now if you see, I might be just outside the capsule here. And so that's a very good sign that we are nearing towards --
01:11:53
JOSEPH L. KOEN, MD: Now, that's very interesting there. Tell us what we're seeing, Vijai.
01:11:55
RAN VIJAI SINGH, MD: Yeah. Well, you can see, we are through the arachnoid here, and the part of the tumor that's remaining and stuck to the arachnoid is right in view there. And as you see, I'm getting my pituitaries here and able to pull out that tumor, whatever is left there. So...
01:12:40
JOSEPH L. KOEN, MD: Maybe when -- when we get this portion out, you can give us a look inside the arachnoid there.
01:12:46
RAN VIJAI SINGH, MD: Yes, absolutely. Give me the one -- small one to the right side. To the left. This is good, yeah.
01:13:01
JOSEPH L. KOEN, MD: So there to the right of the screen, I believe we're actually looking into the brain space, or technically the subarachnoid space, inside that thin veil of pia and arachnoid.
01:14:03
JOSEPH K. HAN, MD: Nice. Nice, Vijai.

01:14:04
RAN VIJAI SINGH, MD: That's good.
01:14:14
JOSEPH L. KOEN, MD: Now have you -- have you seen the optic nerve yet?
01:14:17
JOSEPH K. HAN, MD: No, we haven't seen the optic nerve yet, because I think... We're following the capsule of the tumor and we're able to not only feel it, but we are able to see where the tumor is at and to follow that all the way around until we get that all out.
01:15:21
JOSEPH L. KOEN, MD: I think we have just a few minutes left, guys. Maybe if you're able to, maybe we could get a look inside there. Taking just the last little bit.
01:16:13
RAN VIJAI SINGH, MD: Can you give me the one to the front?
01:16:49
JOSEPH L. KOEN, MD: Well, Joe and Vijai, I think we're near the end. We're going to have to cut away here. And I think a beautiful demonstration of this procedure.
01:17:02
JOSEPH K. HAN, MD: Thank you, Joe.
01:17:03
JOSEPH L. KOEN, MD: And so thank you to Dr. Singh and Dr. Han. We might go back to the prerecorded video for just another minute and a half or so to show you what the very end of the procedure looks like. Thank you, gentlemen. So this is our previous surgery. This tumor was more confined to the sella and this is toward the end. Again, you can see in the upper left-hand screen the diaphragm sella that is bulging down into the operative area, indicating that we've resected the tumor there. If you look closely, you can see the normal pituitary gland deep and to the left. It might be a little hard for you to make out. But we've preserved the normal pituitary gland. This is also a redo procedure, and so the anatomy was somewhat distorted and more scar tissue and so forth. So it's sort of the last look at the end of the procedure, you see the opening in the base of the skull. Just making sure all the bleeding, all that venous oozing, which is very common, slows down and stops at the end of the case. So we're back in the O.R. there. Okay. Yeah, so as you saw there, that is the completion of the procedure. We -- we hope that you have enjoyed this program and found it informative. And so on behalf of Dr. Han, Dr. Singh, and myself, we thank you for joining us today.
01:19:21
ANNOUNCER: Thank you for watching this transnasal endoscopic surgery for skull-base tumors from Sentara Norfolk General Hospital in Norfolk, Virginia. OR-Live makes it easy for you to learn more. Just click on the "Request Information" button on your webcast screen and open the door to informed medical care.
01:19:57
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