Minimally Invasive Treatment of Hydrocephalus
February 11, 2009

Welcome to this OR Live Webcast presentation. Live from the Phyllis and David Komansky Center for Children's Health at New York Presbyterian Hospital Weill Cornell Medical Center. Serving pediatric patients from around the world, the Komansky Center for Children's Health allows medical care to be more accessible, advanced and supportive of the needs of these patients and their families. The focus on children's health is critical, emphasizing health maintenance and prevention. The experience and skill of the physicians, surgeons and other healthcare professionals is unparalleled at the Komansky Center for Children's Health, combining extensive medical knowledge and practice with an inviting environment that demonstrates how we are a pediatric hospital within a hospital. During the program, it's easy for you to make referrals, make appointments or request more information. Just click on the buttons on your screen and open the door.

OR Live, the vision of improving health.

Good evening and welcome to this podcast sponsored by the Komansky Center for Children's Health, part of New York Presbyterian Hospital Weill Cornell Medical Center. I'm your host, Dr. Philip Stieg, Professor and Chairman of the Department of Neurological Surgery at New York Presbyterian Weill Cornell Medical Center. And we're going to be talking to you this evening about minimally invasive endoscopic intraventricular neurosurgery. Now that's a mouthful that we're going to go through in greater detail throughout the entire show. And I'm going to be helped by one of my co-hosts, Dr. Mark Souweidane, who is also on the staff at New York Presbyterian. He is the Director of Pediatric Neurosurgery at Komansky Center for Children's Health at Weill Cornell Medical Center, New York Presbyterian Hospital. And also with me are his patient, Richie, and his mother, Jill, who will be speaking to us about their experiences with minimally invasive endoscopic intraventricular neurosurgery.

However, before we start I just want to remind you that this is a podcast and you do have the opportunity to e-mail in or send in your questions, and we will respond to those later in the show. So please contact us with your questions and we'll try to enlighten you about the details regarding this subject.

Dr. Souweidane, we said this was a mouthful and I'd like to break it down little bit. Can you tell the listeners what the difference or what's involved in minimally invasive surgery and then we'll get you to describe the endoscopes.

Sure. Good evening to the viewer, by the way. The concept of minimally invasive neurosurgery is based on a couple of principles. Surgery, as we know it, typically involves incisions somewhere on the body and then some manipulation of the organs or the body to cure some illness. Minimally invasive neurosurgery is based on the concept of reducing tissue injury while maximizing efficacy of that procedure. So it really is umbrella-ed by the idea that you're going to use less tissue manipulation but also have the same or better result.

Well, then how does an endoscope play into this concept of minimal access, minimal invasive surgery?

It’s a great question and there’s a lot of misconceptions as to whether or not minimally invasive always means endoscopic, and that’s not true. So endoscopic neurosurgery is based on achieving that goal of less tissue injury by utilizing instruments that give you an image of something within the body cavity that is projected on a screen. But it’s that concept of having a lens and a light source that takes an image from inside the body and brings it outside the body so that the surgeon does not need to look inside the body cavity, itself.

I see we've got some of the instruments here with us and it’s probably, like anything else, a picture being worth a thousand words. Perhaps we could show the viewers what the endoscope involves.

Yeah, so this would be an example of a typical what’s called neuroendoscope, an endoscope designed strictly for neurosurgical applications. The endoscope, itself, is composed to two basic pieces. One is the actual lens. This is responsible for getting the image, or transmitting the image, from the very tip, which is where the surgery is done, outside to a camera that’s transmitted to a monitor. That's then housed in what’s called a sheath, which is a protective deice. And that is all in total what the endoscope is. You'll see that on the sheath itself. There are different portals by which you can use small, small instruments that measure in order of about 1 to 2 millimeters each.

So it’s a pretty small instrument and I see it has something else here. Is that something that is involved or related to the endoscope?

It is related and this is what you would call kind of the workhorse of the instrumentation that is used. So you can get an appreciation as far as the small caliber and the dimensions of these instruments, this is actually what’s called a biopsy forcep. And the surgeon can use this to basically do some type of tissue manipulation, biopsy tumors. And that is transmitted or passed through the endoscope itself through this working channel. And when it comes through the tip -- and we'll show this in the live video -- actual surgery that gets done at the very tip of that endoscope. And there’s various instruments of the same caliber: scissors, coagulation forceps, biopsy forceps, etc.

Does every neurosurgeon do the endoscopic procedure or do you have to go on and get special training to do this?

Sure, like everything in surgery, there are individuals who have an expertise in endoscopic surgery. It’s available for any neurosurgeon, however it’s a fairly recent technology. And I think that the teaching that goes along with it has typically not been part of residency training programs, by and large. There are many avenues by which someone can gain training, no question about it, through courses on a national level and international level. But nevertheless, it’s something that has not been, up until really the past five or ten years, an integral part of residency training. So no, not every neurosurgeon does endoscopic neurosurgery.

Does the smallness of this make it harder or easier or you to use?

It’s a fantastic question. It's easier or the patient, it’s harder for me, no question about it. As one who trained through conventional training programs, you are taught to use two instruments: two hands, and look at things in three dimensions.

Through the endoscope you are working through, as I mentioned, a portal that measures about 2 millimeters in diameter, typically with one instrument, and viewing something on a monitor. So it's exceedingly different. Although I don't see it as difficult today, it was certainly difficult during the era by which you certainly learn this

And we want to focus the application of endoscopes in the treatment of hydrocephalus. Perhaps you could talk about, you know, what are the signs and symptoms of hydrocephalus. And I see you also have something that focuses more on the standard there, being that when you start correlating the differences in the way you approach this.

Yeah and I think it's a very important topic to discuss because the endoscope, as much as I think the viewer and the patient views or hears minimally invasive neurosurgery as something that sounds appealing, there are certain applications of endoscopic neurosurgery where it's truly benefited a large number of patients. And one of those is in the treatment of hydrocephalus. Certain forms of hydrocephalus have been, and are still, treated with what's called a shunt. That's a cylastic catheter device that drains fluid from the ventricular compartment of the brain, goes through some regulatory valve process and then down typically into the, you know, cavity . This deice is implanted underneath the skin of the subcutaneous tissue and is meant to live the entire lifespan of that individual. That is conventional therapy. And conventional therapy works and it works very well, however it's a commitment toward an implantable device that has all of the intrinsic properties and complications associated with that, and that is disconnections, breaks, infections, obstructions, etc. Endoscopic third ventriculostomy, the alternative, is one whereby you avoid entirely the idea of implanted devices. And that is a huge benefit for the patient from the standpoint of avoiding every one of those complications that are associated with implanting a shunt.

Does a person with a shunt have to do anything in particular? Are they limited in any activities? If they have another surgical procedure, are there specific ramifications that they have to worry about? What are the limitations with the shunt and is the endoscopic third ventriculostomy therefore advantageous or better to use?

Yeah, it's a very important question and there's a number of messages that should be sent out to the individual who is a beneficiary of endoscopic third ventriculostomy. That individual has hydrocephalus, that individual has been treated for hydrocephalus and they still need to maintain a connection and interaction with their neurosurgeon or neurologist to make sure that is still maintaining function with regard to treating their hydrocephalus. Shunts, in and of themselves, aren't necessarily limiting to the individual but it's somewhat more restrictive in the amount of time and maintenance that goes into the continuous treatment via a shunt compared with endoscopic third ventriculostomy.

So you didn't get into the signs and symptoms. I think that might be something, because I know that later on in the show Richie is a little bit of an atypical story and maybe we could go through what the doctors and patients that are looking at this show might be interested in.

Yeah, it's a great question for the individual who many times don't know they have hydrocephalus. And it's typically the case. Hydrocephalus manifests in different ways, depending usually on two factors. One is the time duration by which

hydrocephalus has been present. The other is the age of the individual. I specialize and focus my practice on pediatric neurosurgery, and young individuals less than two or three years of age manifest in a much different phenomena than older individuals, older children or adults. Typically the young infant will manifest with raised intracranial pressure that is shown by an increasing head circumference, a very, very basic principle of maintaining a good physical exam on a child. So those individuals can also present with irritability, feeding difficulty, behavioral symptoms that are somewhat ill-defined and very difficult to diagnose. In the older child or the adult, where the skull is more rigid and limited in its ability to expand, the manifestations are somewhat more obvious to the individual: headaches, vomiting, cognitive changes, some difficulty with walking, and, if rapid enough, can ultimately result in difficulty with vision, strokes and death.

I'm sure probably some people are watching this wondering about, you know, the diagnosis. You can't turn the TV on nowadays without hearing about normal pressure hydrocephalus. Are endoscopes a way that you can treat that disease?

Yeah it's very, very smart to categorize hydrocephalus because the treatment regimens are different. You've mentioned normal pressure hydrocephalus, which is typically a form of hydrocephalus in the elder population that has a different set of circumstances, pathology as well as manifestations. It's being looked at currently and our center is one that's looking at this in a scientific, prospective say to determine whether or not endoscopic third ventriculostomy can be utilized effectively for normal pressure hydrocephalus. In the strict sense, and certainly I think what most people decide as far a a consensus statement on endoscopic third ventriculostomy today, it's treated for what 's called non-communicating hydrocephalus, a form of hydrocephalus where this fluid, cerebrospinal fluid, does not get from the ventricular system to the subarachnoid space, a very particular form of hydrocephalus.

I can say this, but you wouldn't, I know. Dr. Souweidane is one of the thought leaders in the application of endoscopic therapy for hydrocephalus. And we thought that it would be beneficial to you, the listener, for him to give a brief presentation to us on the applications of the endoscope for intraventricular disease processes.

Thank you, and I think it will answer some questions that the viewers may have. If we go to the PowerPoint presentation, what I hope to communicate through this is the difference between conventional neurosurgery and minimally invasive, or endoscopic, neurosurgery. I've included several images that will give the viewer an idea of that neurosurgery entails. It's a safe endeavor. I don't want to give it the wrong- or give you the wrong idea. Neurosurgery is done on a basis, on a daily basis, fairly, fairly routinely with very little morbidity. But you can see from some of these images that involves removing or manipulating a large portion of the skull, as you see indicated in this image. This is another view of where a portion of the skull in the back of the head has been removed prior to removing a tumor. And this is the view you would get. You see the brain, you see the pathology and you then begin with two instruments, as you can see there on the PowerPoint slide. And this is what the surgeon is seeing. The surgeon is looking at the brain and the instruments using two hands, as you see depicted in this image here. Compare that with endoscopic neurosurgery, and if you look at the entry where that instrument goes through the skull, it's a much smaller opening. This measures about 7 to 11 millimeters in diameter. The endoscope is passed though that. The surgery is done and it's removed. This is what the surgical field looks like, compared to that conventional

form. The surgery is done by looking through a monitor, as you see depicted here. And this is the view you get: a view that is very, very good with regard to image and light transmission, excellent detail and offers you a great advantage with respect to seeing into the depths of the brain, which are very difficult to get to via conventional neurosurgery.

Endoscopic neurosurgery, this is what the OR area looks like. We're going to show you actually the surgery in a moment so you have a better view of that. And this is the result. This is a gentleman that underwent endoscopic removal of what's called a colloid cyst, a very particular benign tumor in the middle of the third ventricle, a very difficult area to normally get to. And this is his image several years after. It's hard to even see the site of the incision. We had an incision on the forehead, itself. But the end result of all this is that there is less brain manipulation. There is decreased morbidity to the brain itself. A shorter hospital stay has been shown with many of these tumors, improved cosmetic result, avoidance of implantable hardware in the case of endoscopic third ventriculostomy or congenital cysts. The applications are many. You see those depicted in blue with the pathology on the left. I'm not going to go over every one of these in detail, but alterations in CSF circulation typically by way of hydrocephalus or what's called compartmentalized ventricles, congenital cysts -- arachniod cysts being the most common -- and then brain tumors where it's burgeoning as far as the investigation under the endoscope for therapy -- been proven time and time again the benefit for taking out tumors such as colloid cysts, pineal region tumors. And then lastly we're now exploring the concept of doing scalp masses to avoid incisions on the surface of that.

In term of some of these things also, it's safe to say that people are trying to expand the applications of the endoscope to even larger types of tumors than what you're mentioning here, correct?

No question. What we're doing today, Phil, is dramatically different than what we were doing in 1995 when I got to Weill Cornell and New York Presbyterian Hospital. A lot of that is governed by not just the interest and the exploration of different technology, it's having investment in individuals like yourself who lead programs where there is a known benefit, an initiative to develop this technology, by the Center itself in investing I capital equipment to drive really programs like this that are state-of-the-art, no question about it. What we're going to talk about in this segment with regard to the actual surgery is something called endoscopic third ventriculostomy. We touched upon that before. As a bypass procedure, you're taking fluid from inside the ventricles and then making a small perforation in the floor of the third ventricle to allow fluid to reinitiate a normal sense of flow. So it goes from the ventricle to the subarachnoid space -- what CSF typically does, normally does. So when there's an obstruction, you bypass that obstruction, return it to a normal place of resorption, and that's the concept and that's the basis behind endoscopic third ventriculostomy. This is an artist's rendition of what that looks like. We've talked about the benefits, the patient selection. We did talk about non-communicating hydrocephalus. The other thing that has been borne out of large prospective studies: that individuals less than the age of one don't respond as well. While it an be used in certain circumstances, the success rate is certainly less. Greater than the age of one, if the patient selection is rigid, about a 70 to 80 percent success rate. This is the alternative. So this is a individual who has had multi-compartmentalized hydrocephalus. And on this skull x-ray, you can see a number of catheters implanted in different ventricular compartments. And you can easily understand the difficulty in assessing problems when that patient ends up in the emergency room with a

potential shunt malfunction or, god forbid, an infection that necessitates taking all that hardware out.

How often do these shunts malfunction, went you put them in in a child versus an adult?

It's strongly dependent, as you indicated, on age. Good studies that have looked at the survival and the lifespan of a shunt in an infant, that survival is somewhere between 40 and 50 percent in one year. So that gives you an idea of the frequency by which shunts are revised.

The life-long, hence the desire to come up with different technology or better technology for treating this disease.

Unquestionably, unquestionably. Endoscopic third ventriculostomy, as we mentioned, with regard to their type of hydrocephalus depicted there, and this is what you see at the time of surgery that we're going to show you, as we saw in Richie's case. And this is the flow of the third ventricle on the left. That's when the perforation is made.

This is deep inside the brain.

This is about as deep and as centered as you get in the brain through a 2-millimeter endoscope. You get excellent image resolution with regard to the anatomy. And then the image on the right is actually after the stoma, or the third ventriculostomy is created, then you can nearly clearly see into the undersurface of third ventricular surface into the subarachnoid space. We'll go over that anatomy a little bit later. And this is the MRI scan afterwards that depicts what we call a patent third ventriculostomy where you can actually see on MR now flow through the site of the fenestration. So MR has become really the tool of measuring the success of endoscopic third ventriculostomy. We've touched up on this and I can't stress enough that, although the technology is fantastic, the concept is wonderful, in the wrong hands it's not. And like anything else in surgery, it has the potential of causing catastrophic outcomes if not handled properly. So we at Weill Cornell and New York Presbyterian Hospital invest a lot of time in education: yearly courses, CME courses, on the teaching of endoscopic technology, both in the intracranial compartment as well as the skull base. It is an integral part of making sure that this technology is realized for the patient as far as the benefits.

It's probably also important to emphasize that the Komansky Center for Children's Health really helps support you and pushes this kind of technology.

And no question about it. As we touched upon the investment of this not just in the time by the surgeon, but the capital investment for this technology is great. The maintenance of this alone is really prohibitive for a lot of neurosurgeons.

I don't know, some of you, I'm sure, remember that view of deep within the third ventricle of the brain and makes me always think about Socrates talking about the seed of the soul being the pineal gland. And Dr. Souweidane is always lucky enough to have that view on a regular basis. Perhaps we could take this to the video that you've created for us so that the viewers will more greatly appreciate the quality of the image that you actually get through this little 4-millimeter thing.

That's exactly right. So what we're seeing here is actually Richie's surgery. And what we're seeing here is an endoscopic third ventriculostomy. This is the initial entry into the lateral ventricle. You see the choroid plexus there at the bottom of the screen, normal vascular anatomy. And what is happening here is the endoscope is being rotated, not changed in its trajectory, but rotated on this own access to give you different views. This is a 30-degree angled endoscope, which gives you ultimately 60 degrees of view from one end to the next. So this is being rotated toward the midline there. Very common in chronic hydrocephalus are these multiple fenestrations already created in what's called the septum pellucidum the membrane between both lateral ventricles. And you see that orange glandular frond-looking tissue, which is the choroid plexus. And that is the generator where CSF is produced. So you can see the excellent image resolution. This is on an HD screen, a high-resolution screen, which is a recent development. You were talking about the progression of the technology and that's one of the more recent developments that we have.

We emphasize that the white fibers right there and the importance of the hand to Richie's function today.

That's exactly right. That small white fiber that we're moving under right here is called the fornix. There's one on either side and that sub-serves short-term memory and is very unforgiving when it's injured. We're now in the third ventricle with the endoscope here and you see most anteriorly at the top of the screen a white structure, which is what's called the optic chiasm. That's where both optic nerves come together before they cross fibers and go to the back of the visual radiations, optic radiations. The red dot behind that is something called the infundibular recess, a very important landmark for doing safe third ventriculostomy. The blunt forceps are now being brought in to the floor of the third ventricle. By the way, this is approximately 1.5 millimeters, as far as that working instrument. And now what we're doing is we're palpating the floor of the third ventricle just before the perforation. You can see the perforation there made. That little white mark in front is part of the skull base, called the dorsum sella or the top of the clivus. And you can see that the floor of the third ventricle will start to pulsate, indicating that flow is flowing to and fro. I'll and that the safety of this is governed by good technique. This balloon catheter, which is dilating up the floor of the third ventricle in a very traumatic fashion, so we're avoiding any energy sources to avoid any inadvertent injury to a very important vessel which is on the far side of this, called the vasular artery.

So you can see now the endoscope is being moved through that fenestration to show us that there is a clean line of communication between the intraventricular and the subarachnoid space. Small air bubbles there, you can see them pulsating consistent with the to and fro motion of fluid. That entire procedure takes on the order of about 15 minutes. And the scope is then withdrawn. And as the scope is withdrawn, that will come out of the skull surface and the wound is closed in approximately three to five minutes. It's an incision that is about 1-1/2 to 2 inches in length. And that's the completion of the endoscopic third ventriculostomy.

So this is amazing what you're able to show with something like this. What I- on the flip side of it, you know, I tried to highlight, you know, the possible impact on Richie's memory by going past that anatomical structure. Can you highlight for the listeners what are the possible risks associated with this so they- it looks easy in that video but when things go south, they go sound.

Yeah, that video is about 15 years worth of experience and somewhere on the order of about 300 patients worth of experience. You're exactly right, and the listener and the potential patient needs to know that catastrophic changes can happen. Patients have died from this procedure by way of injury to the vasular artery. Short-term memory can be injured quite easily if the scope is not manipulated properly in a frame in foramen midrow where that fornix outlines the anterior and superior part of that structure. So no question that potential for morbidity is there. Again, I'll stress again, educated properly in the right hands with experience, that morbidity should be, and is, across the world in experienced hands very low.

And to point out, would this operation be possible without the endoscope?

It's a great question and one that holds particular interest from the standpoint of the history of neurosurgery at the institution by which you are now chairman. Russell Patterson actually talked about and actually published series on endoscopic third ventriculostomies in the 1960s and ‘50s. And that procedure was being done via an open conventional approach. The concept is nearly 100 years old. The decrease in morbidity is governed primarily the way of the innovation of the endoscope and the reduced caliber that allows us to use this on the brain.

Do we have another video that we can go though to demonstrate further the applications of the endoscope?

Yeah and I think it's worked well. This is actually at the time of Richie’s surgery. And this is important so that the viewer really appreciates the minimally invasive quality of this actual procedure so they’ll get an idea of what is being done with regard to the sizes of what we're doing. So Richie’s actually fixed. He’s under general anesthesia, he doesn't feel anything. The head is secured. You saw those dots on the head? This is an MRI scan performed the morning of surgery that gives us exact detail with regard to the trajectory that we want to optimize. It’s important to note that when we put the endoscope in the ventricle, we don’t have the liberty of moving that trajectory which- with much enthusiasm at all. Any movement of that endoscope and the trajectory potentially causes injury to him, so we go though great pains and advanced technology with stereotactic integration to make certain that that initial trajectory is exactly where we want to be, so there’s very little in the way of manipulating that endoscope. And this process that we're going through right how is actually registering the endoscope itself as a tool, and a navigational, tool that allows us in three dimensions to know exactly where that tip is at all times, taking all the guesswork out of entering into is young man’s ventricle and ultimately the third ventricle. And that’s what’s being done here. Once that is registered, we then have the ability to take that trajectory, mark it on his skin and then prepare the skin accordingly.

Awesome.

It’s probably interesting to note that when Richie was born this technology didn’t exist. And so he’s the product, he’s the beneficiary of the advances of this technology.

Yeah he is. And it’s really difficult for Richie to appreciate the benefit of this. The person who really truly appreciates the benefit is the person who was previously shunted for hydrocephalus. And those individuals are candidates for endoscopic third ventriculostomy. The person who has gone through multiple shunt complications and

revisions truly appreciates the gravity of that advance. There you can see the actual surgical site that's being prepped. The site is being marked with the navigational sculpt that's integrated into the stereotaxy. We don't shave the head and that's fairly typical of most neurosurgical procedures, minimally invasive or not. A small, small area of the hair is parted. That is then shaven to allow us access and really for easier closure. But to give you a reference as far as orientation, his nose is toward the top right of the screen. The back of the head is toward the bottom left of the screen. And that's the entire site that's going to be utilized for the exposure right there. That's the infrared camera that helps us with constant updating of the navigational device that we know exactly where that endoscope is here. So appreciate the adaporative field and the relatively small size. This is after the prep, the betadine prep, the small size of the exposure by which we'll gain access in to the ventricular compartment.

Of course, Richie's asleep here, not feeling anything, totally unaware of what's going on.

That's exactly correct. I always tell usually young individuals that they have the easy part of the job. They get to sleep through the procedure. But nevertheless, the parents have the most difficult part of this job, in my opinion.

Other than using the image guidance system, are there any other particular special things you have to do for this or is there actually less to do with this than an open craniotomy?

There's less with regard to equipment that's required. I think there's more with respect to the training. The integration of the nursing staff, the integration of the personnel in the operating room, needs to be up to speed with regard to this going smoothly. I mentioned that this takes me about 15 minutes. I can tell you that when we did our first procedure, endoscopic third ventriculostomy, in 1995 that probably took on the order of about two hours. We were utilizing borrowed endoscopes from the Department of Urology, our nursing staff that weren't familiar with the equipment.

So this is like many other things in surgical sub-specialties: high-volume places are where you want to send your loved one.

Without a question, not a question at all. So you can see there the prep is finished. The actual incision site will be marked there. And as I mentioned, that's about an inch, inch and a half in length right about there.

So what are you doing here?

So this is all part of the preparation to reduce infection. The prep was done, the skin site is marked and this is a, what's called an IO band cover, which is an iodinated impregnated occlusive dressing to help reduce infection. Infection, as much as it's a problem with shunts, interestingly has been a very, very infrequent and in experience never happened yet with an endoscopic third ventriculostomy. So it's a very, very rare occurrence. But we still take the same precautions as you take in any surgical procedure. A sterile drape is being applied.

While we're waiting and just sort of seeing the routine parts of surgery, we did get one question from a patient actually who said, "My child was born in New York Hospital 14 years ago" and apparently has had three revisions in his life with normal

ventriculoperitoneal shunts. I think the last one may have been done 11 years ago. But they're wondering would they be a candidate for this surgery. And so how does one go about determining that?

Yeah, it's critical that the individual or the parent of a child know that it's a treatment alternative. Without that knowledge, it may be impossible for them to ever know. Part of shunt technology and part of the whole art of shunt surgery really is based on immediate attention to a shunt malfunction. It can be a life-threatening problem, so many of these individuals end up in an emergency room where it's highly probable that the neurosurgeon there on staff might not have the technology or the wherewithal to do this in a safe manner. So without asking, they might not know. But just to stress another point, an individual with non-communicating hydrocephalus and a shunt malfunction is a candidate for endoscopic third ventriculostomy. It's a more difficult population, it's a little bit more of a difficult technical experience. But nevertheless, the success rate, with rigid selection criteria, is about 70 percent in our hands. So the burr hole has been created here. Burr hole- that measures about 11 millimeters in diameter. That covering that's being incised now is called the dura matter.

The dura matter is a very thick covering over the surface of the brain. And you'll see there is a moment, as you get into the intracranial compartment, actually beyond the dura then you'll start to see clear, colorless fluid. That's actually CSR, or cerebral spinal fluid, pulsating out of the intracranial compartment on the surface of the brain in the subarachnoid space. What's happening right now is this endoscope, which I just showed you a moment ago, is now integrated with the stereotactic system, the navigation system, by way of those three reflecting spheres. And what the surgeon is doing is actually selecting the optimal trajectory that we want to use to get into not just the ventricle but the third ventricular site where we can do the perforation, or the fenestration. And that by doing this now, it eliminates all of this potential movement, once this has passed through the brain, itself. It's wrong to say that this is not invasive. This is still a very invasive procedure. This is a 6-millimeter scope and sheath going through the surface of the brain and the subcortical tissue of the brain.

But in comparison to other things, it's about the same, correct? The diameter of the shunt tubing is maybe 2 millimeters?

That's correct.

-as an order of magnitude.

That's exactly right.

Everything you have to do is invasive.

No question about it. So we showed you the actual images from the intraventricular view. This is the scope is now inside the ventricle and you see some of the fluid, which is pulsating out of the working channel at the top of the endoscope. And I might add that there's constant irrigation here, which helps keep our field clear and also stops the ventricular system from collapsing from too much CSF egress.

Well, the viewers are seeing the endoscope here, but you are watching a TV monitor to look at the inside of the brain, correct?

That's exactly right.

-what we saw on the earlier film clip.

Yep, what the viewer saw is actually what we're watching on a monitor at the foot of the bed. Yep, that's exactly right. So again, appreciate the fact that is a very, very small opening and we're not looking at the pathology, or the structures, through the brain itself. And I think I'll pan over and show you the video in a moment so you can see our image or our view is directed toward a monitor placed at a remote site, at typically the foot of the bed to make it more comfortable for the surgeon.

I can't help noticing the way you draped me over, it looks like I'm dead.

No, you weren't. [crosstalk]

That's why I'm here now.

So there you see the actual monitor that we're viewing while we're doing the third ventriculostomy. The image is not as high resolution because this is taken off the monitor rather than through the tape that we had shown you earlier. So this is actual in real time while we were holding the endoscope in position. You'll see them pan out and show you that in a moment. And this takes-

This is a real-time video, correct?

It's a real-time video, that's exactly right. And off to the right you see the monitor for this stereotactic system, the navigational system, that ensures that the trajectory we wanted is exactly where we are. And for most third ventriculostomies, the integration of navigation is not critical but, again, if it reduces any amount of guesswork, in my estimation, it reduces morbidity and that's been our experience in endoscopic surgery.

Before we had the technology of the image guidance, were you still able to do this operation?

We were able to do this operation. There's a lot of other operations that we are not able to do without image guidance. Or I shouldn't say not able to do, but do as safely. We talked about removal of brain tumors in the pineal region, or colloid system, the third ventricle. Without question, that demands precise navigational guidance. We've also mastered and we've published on the topic of doing this in individuals with normal size ventricles, which is a very, very difficult endeavor but should never be attempted without some navigational assistance. That's correct.

You're showing inside the ventricles, you see some of these blood vessels, what happens if you just inadvertently tear a vein and get some bleeding? What do you do?

Yeah, invariably there's always some element of bleeding. The hard part of endoscopy is getting used to the fact that that happens with any surgical procedure, be it a shunt or anything else. The difference is we're watching it, we're seeing it in a magnified and very, very illuminated way. But the great majority of the time that bleeding does not interfere with the procedure that we're doing. If it does happen,

and if there is some problem with bleeding that obscures your view, the irrigation that we're utilizing right now takes care of the great majority of that. It cleanses the CSF and most of the bleeding will stop by way of irrigation. We have other devices, such as coagulation devices, balloon tamponade, that we can utilize as well very effectively. And there you see the balloon catheter that we were using to dilate the floor of the third ventricle being moved into the site of the fenestration and dilating that fenestration. That ultimate dilatation measures about 4 millimeters in diameter at the tip of that.

So you did this procedure, do you ever have to redo it?

It's a fantastic question and it's a question that I don't think we have a full handle on yet. A repeat endoscopic third ventriculostomy is done very successfully. What seems to really weight into the success of repeat endoscopic third ventriculostomy are those that have an interval of time where it was successful for some period of time, usually measured in not months but even years. Those that fail endoscopic third ventriculostomy usually fail because of whatever caused the hydrocephalus causes some inflammation and scarring of the site of the fenestration, examples being infection, hemorrhage. So those that see a benefit of the third ventriculostomy, we will commonly do repeat endoscopic third ventriculostomy.

So if they fail quickly, they're probably not a good candidate.

That is correct.

But if they fail long-term and long-term means what, a year?

Usually several months of a year, yeah.

And then you would consider going back in and doing this?

Without question. The longest interval we've had with regard to a repeat endoscopic third ventriculostomy was ten years. Yeah.

So I think there's probably a number of physicians and patients sitting out there watching this wondering, gosh I've got this shunt in my head and I'm just like Richie. I want the thing out. Can we give them some quick cues as to what might make them a good candidate?

Yeah, I think there's some quick cues and those are very accurate MR diagnostics with respect to qualifying or really specifying what type of hydrocephalus it is. There's a form of hydrocephalus that is commonly billed as non-communicating hydrocephalus. In the event -- and I stress -- in the event of a shunt malfunction, they're candidates. This should not be, in my opinion, taken as a means for removing a shunt on an elective basis. The great majority of shunts work. The work well and they work for very long periods of time. So we do not want to get into the practice of individuals wanting their shunt out and performing endoscopic third ventriculostomy. There is morbidity with removing a shunt, there's morbidity with performing endoscopic third ventriculostomy. But if they have non-communicating hydrocephalus and the presence of a shunt malfunction, they are candidates.

Now can you point out for the listeners the difference in terms of the whole hospital process? We saw here on this video in real time that it takes 15 minutes. So Richie

what, went to the recovery room and did he go home that day or did he go home the next day? And what's the difference between that and a shunt?

Not much difference with respect to the hospital stay. The difference, with respect to differences, really is borne out of more difficult procedures such as colloid cyst removal and tumor removals. And to give you an idea about that difference, colloid cyst removals through and endoscopic procedure that we do today, that's usually an overnight hospitalization. By and large, it's usually about a one-week hospitalization for most colloid cysts that go well through microsurgical resection. For a shunt surgery, the placement of a shunt, anywhere between a half an hour and an hour routinely and usually an overnight stay for an elective shunt. So the overall impact, from the standpoint of the acute hospitalization -- not much different. The benefit comes from the lifelong commitment of a shunt compared with endoscopic third ventriculostomy.

It's probably a little bit different in adults for shunts though. They don't seem to tolerate the belly part of it as well and they, you know anyways it looks to me like Richie probably left the next day. So there would probably be some advantage there. Why don't we bring Richie and Jill into this a little bit. They've been patiently sitting here watching Dr. Souweidane and myself talk to you about the merits of endoscopic third ventriculostomy. And again, I want to express my appreciation for the two of you coming here and spending time with us. But you know, Richie, you're an articulate young man and I should let you all know today's his birthday. So he's particularly kind to -- and I want to ask him how old he is -- to come and spend time with us. So Richie, tell us how this came about. How did you find out that you even had hydrocephalus?

Actually I was participating in a clinical study at Yale because I had absence seizures. And they wanted to compare that to what a normal brain would be like. And when they were viewing the tapes they saw hydrocephalus.

And they walked out and told you, Jill, that we think your child has hydrocephalus. And what was your first response?

Well, uh you know-

My son's normal.

Right, I got a call. I got a call from the principal investigator of the study who said, "We had an incidental finding on the MRI." And he didn't really come right out with the -- he said this is enlarged ventricles. He tried very carefully to not upset me. And he said, "You need to talk to your neurologist about this," which we did. And he also tried very hard not to upset me. And -- but I was surprised mainly and I was concerned in part because we had just dropped him off in his first summer camp experience. And I was wondering whether I then had to run and pick him up and, you know, if he was at risk there. And because he had an unusual situation where there were very few symptoms, it was determined that he wasn't in immediate risk but we're going to proceed to thoroughly investigate and make good decisions, you know, at our earliest opportunity. So that's what we did.

What does "thoroughly investigate" mean? Does that mean --

Well, first, as the doctor mentioned, have a thorough MRI so you could get good clinical diagnostic information. That was the first thing that we did. And once we had seen that, we spoke to our neurologist, Dr. Overby and he said, “Yes, in fact this MRI confirms what was discovered in the study. And so you need to have a consultation with this neurosurgeon.” And he gave me Dr. Souweidane’s name and then he sent a little more information and I'm sure you're going to look it up, which I did.

Describe that interaction. How important was Dr. Souweidane in helping you make the what you, I presume, think is the right decision for Richie?

Well, crucial because --

What he do that was crucial?

He helped us understand that the effects of Richie’s hydrocephalus would maybe not be immediately apparent to us. We came into the meeting with Dr. Souweidane with the belief that if he wasn’t having episodes of blurred vision or dizziness or altered gait, that there was no problem, that this was just-

You thought he had time.

We thought we had time and we thought that we would maybe never have to do anything which, of course, would be where you would immediately want to go if you're the parent. You know, okay we really don't need to have surgery was sort of where I was going.

Mom, you look worried, relax.

I'm not worried. I'm not worried, we're good now. And so but Dr. Souweidane helped us understand that there are cognitive issues that can arise sometimes very gradually and memory issues. So that gave us a reason to really-

I presume Dr. Souweidane went through with you the options of as shunt.

Yes.

-- versus the options of a third ventriculostomy. Did Richie ever have a shunt?

No.

Why did you decide to have the third ventriculostomy?

Why wouldn't you? I mean truly, that -- if I have -- well for one thing, Dr. Souweidane presented in such a way that was so elegant seeming because its --

And accurate.

And accurate. You know and elegant in the sense of being not -- not unduly complicated but it’s very straightforward and easy to understand and made sense.

So the beauty was that Richie was apparently a pretty ideal candidate for this type of surgical procedure?

Yes.

All right, so Richie how old were you when this was all happening?

I was 12.

12, so what was your response when mom dad said, “This guy wants to give you a little bit of a haircut and put a hole in your head”?

Well, I have never been hospitalized in my life besides my birth, in which I was just coming out of my mom’s stomach.

You're sure about that.

Yes. Don't worry, it wasn’t a C-section. But I didn’t want to get my hair cut because I'd heard of brain surgeries that involved shaving of the head. But I kind of felt a little bit scared, a little bit excited like I'm getting brain surgery.

It was fascinating, right?

Yeah, I was intrigued, I was interested because I’ve always wondered how like little small things happen.

Any little tricks that you had for coping with it or did you just not think about it?

Well, I do believe in God and you guys have a chapel in your -- you guys have like a small church for us to pray, so I prayed there for it to go well and right before the thing. I haven't really been committed any sins that would cause me to go to hell, so I prepared myself if I did die. I went, okay, if I die I'm probably going to go to heaven.

I'm sure Dr. Souweidane reassured you that the chances of that were minimal though.

They were -- she was really more worried than I was.

So you went through the procedure.

Yep.

And was it as bad as you thought it was going to be?

To be honest, I didn’t -- it was about exactly how I thought it was going to be, except for the vomiting. I didn’t expect the vomiting but there was only like five throw-ups which is actually better than the ’05 Christmas where I spent the entire day sick.

Right, we don't need to go into that. That's due to the anesthesia though, the nausea.

Yeah, like sort of --

I mean it just like --

Tell me about the reintegration. An important part of children that have surgery, be it neurosurgery or otherwise, other peers, other fellow students view them and how their family views them. Was there any issues there?

Well, there was an annoying period the first three days I got back from school and everybody was like, “Oh, how’s your surgery go?” And at one point I think I actually yelled at a person for saying that because I got so -- because it got so annoying. I showed a few kids my scar. A few kids got scared of it. I think one girl -- I'm not sure if the girl fainted or not but she got really scared.

I have a question here from someone in the audience that says, “My baby, 10 months old, has been suffering from hydrocephalus since birth. He was born with this condition and ever since, his head has been growing too much. Do you think the treatment is suitable for him?” Dr. Souweidane?

Yeah, very similar to the response of the individual that asked the question about having a shunt and whether or not they're good candidate for an endoscopic third ventriculostomy, it starts with a good definition of what type of hydrocephalus it is. If you are not cared for by a person who’s familiar with diagnosing different types of hydrocephalus, namely a neurosurgeon or a neurologist, that is something that anybody who has treatment for hydrocephalus should be integrated with, first and foremost. And that person could usually give you a very good idea as to whether or not you have a form of hydrocephalus called non-communicating hydrocephalus.

You've been talking about this a lot, non-communicating hydrocephalus, can you clarify for the listener how they go about getting the diagnosis of non-communicating hydrocephalus? Because I think once they understand that, then they’ll understand whether they might be a candidate for this.

Yeah, sure. Let me first say that it’s not always clear to us, as an individual who does this on a daily basis. So it’s not always black and white, and sometimes there’s a lot of overlap. There are multiple facets that go into the cause of hydrocephalus and many different etiologies. What we're referring to when we refer to communicating or non-communicating hydrocephalus is the ability for the fluid, the CSF, to get out of the ventricular system and back into the subarachnoid space over the surface of the brain where it normally gets reabsorbed. If there's something that inhibits that fluid from getting out of the ventricular system, it's labeled non-communicating hydrocephalus versus a communicating form where it actually gets out of the ventricle, gets into the subarachnoid space but doesn't get reabsorbed properly. And most times an MRI scan will give you that information.

Did Richie have that classic MRI scan where I presume you're talking about the aqueduct-

That is correct.

-which doesn't have flow in it. Did Richie have that?

Yeah, Richie had an idea anatomical definition of non-communicating hydrocephalus, by the way what’s called aqueductal occlusion. And aqueductal occlusion can be due to many different etiologies, but really the ideal candidate is one who has acquired aqueductal stenosis.

One of the questions for the listeners, they are watching this closely and they noticed that you had this bubble at the end of the instrument. And they're asking is that bubble-looking apparatus kept in the third ventricle?

That's a great question and again-

Congratulations to that listener.

Very insightful, someone's watching.

He should be a detective.

The bubble, that balloon catheter which allows us to dilate that fenestration in a very atraumatic way does not stay implanted. The beauty of endoscopic third ventriculostomy is that we avoid any implanted hardware. And that is really the big benefit of doing this, that you reduce any risk of infection, you reduce any risk of mechanical complications. So nothing is left in place. You may have seen that we do leave a small titanium cover over what we call the burr hole. And that's just to reduce the cosmetic impact of this so that the patient does not feel a small divot on the surface of the scalp.

If a person- I'm changing the question here a little bit from somebody, but if a person has a shunt in place but they want to be considered for the third ventriculostomy and you determine that they have "non-communicating hydrocephalus," what do you do with the shunt if you do the third ventriculostomy?

Yeah, there's a lot of difference of opinion as far as how best to manage the shunt. A lot of it's dictated, in my opinion, based on how sick that patient gets with a typical shunt malfunction. Everyone's a bit different as far as their presentation when a shunt goes bad. I always encourage patients to leave the shunt in place, pending a confirmation that the endoscopic third ventriculostomy works. And in the face of it working, then certainly plenty of discussion can be had with a patient regarding removal of that shunt at that point in time. So I think, as a safety maneuver, I like to leave the shunt in place, perform the endoscopic third ventriculostomy, confirm that it's functional and then, if the patient agrees, removal of the shunt at that point in time.

This is an excellent question, one thing that you haven't touched on. We talked about it before the show. For somebody that wants to get more information both about hydrocephalus and/or shunts or endoscopic third ventriculostomies, what Web sites should they go to or can they go to?

Like everything else, the Web site is replete with information. What the important thing is that it's accurate information. There are a number of Web sites that one can visit at the Weill Cornell Department of Neurological Surgery Web site, we have plenty of information on minimally invasive endoscopic neurosurgery as well as hydrocephalus and its treatment. The Hydrocephalus Research Association is very valid Web site that can be visited for more information. And again, the source of the information is what's critical here. There is a lot of information that I'm sure you were exposed to and it's hard to decipher, from a parent's or patient's standpoint, what is accurate and what is not.

May I ask a question?

Absolutely.

Sure.

The titanium plate you put in my head, will that be picked up like when I'm going through a metal detector scan to get on an airplane?

Absolutely not. And you can go through an MRI scan very safely if need be.

Oh, cool.

And you, being 13 years old, I'm going to ask you why.

Because when my family went to Disney World, my cousin had given me a birthday card that had some metallic lining on it. And we were going through the metal detector scan and I had it in my pocket along will a bunch of other toys that are mainly plastic, which were a lot sharper than the card, by the way, and I got pulled into the booth.

Set off the alarm?

Right.

And I was like seven.

But this is- the good news is this is titanium. And you know that's important for people to understand. It's made out of titanium. It's non-ferric, therefore it doesn't set off the alarms.

I think yeah, I see a number of questions in this regard and I'll try to summarize it. You know, my ex-wife or my wife, 81 years old, has hydrocephalus. Would they be a candidate for this? And I think that, again, companies like Codman have done an excellent job of increasing the awareness about normal pressure hydrocephalus and its potential role in dementing processes. So certainly patients would like to be candidates. What do you advise to them about how to go about finding out whether they're going to need a shunt or this third ventriculostomy?

The most important issue, again, is to see an individual who specializes in the care of hydrocephalus, be it adult or a pediatrics. And it starts there with either a neurologist who is an expert in the field or a neurosurgeon. Are they a candidate for treatment by way of shunting or endoscopic third ventriculostomy usually falls under the experience of a well-trained neurosurgeon. So again, good radiographic definition, good definition as far as what type of hydrocephalus and an individual who is experienced in that field.

Age is somewhat irrelevant. Anyone's a candidate for either procedure.

Well, that relates to this next question from someone from California. They have a seven-month-old child who is going to have an ultrasound looking for hydrocephalus and they're wondering if their child is old enough. So perhaps you could generalize

your answer and say what's the youngest patient you would be wiling to do this on and the oldest.

Yeah, so the youngest patient that I would be wiling to do it on, as we have, are children at one day of age. And we have detected hydrocephalus in individuals in utero and on day one of live have performed endoscopic treatment of hydrocephalus. And this has been successful. As I mentioned earlier in the segment, individuals less than the age of one year have been shown to have less of a success yield or rate. And that's somewhere between 40 and 60 percent. If you are very, very selective in the type of hydrocephalus, you can increase that to some degree. But as long as the parents and the patients are understanding of the fact that it may require a second operation if the endoscopic third ventriculostomy does not work then certainly I think, in my estimation, if you can eliminate shunts in half those patients less than one year of age, it's still a very valid treatment alternative.

We have some very good detectives watching this show. This question is, is there any risk of scar tissue closing the hole. I think you mentioned something but perhaps you can go into what's the frequency or the relative risk of that occurring.

Yeah the frequency, we're not quite certain of. One thing that has gotten in the way of good outcome analysis in endoscopic third ventriculostomy is it's not that old of a technology. I think as far as mainstream, if you will, this is really still continuously catching on on a yearly basis. But we have about ten years of very valid data on a lot of patients. The rate of reclosure is somewhat nebulous. We don't know exactly. However, as I mentioned before, with reclosure they can manifest, that patient can manifest the same way an acute shunt malfunction can manifest. And sudden death has been described in endoscopic third ventriculostomy reclosure. Those are usually patients who have very, very stiff ventricles, if you will, or get very, very sick when things like that do happen. So we don't know the exact frequency. In my experience, we're done probably close to 400 endoscopic third ventriculostomies and those beyond one year we could probably count on one or two hands at most. So it's pretty infrequent and it requires that we do maintenance MRI scans on a yearly basis to establish that any reduction in flow or absence of flow necessitates a discussion about reexploration and possible refenestration.

I want to change this question just slightly. It says, "I have water on the brain and my neurologist said that I was too young to have atrophy. I'm 58 years old." May we change that a little bit to the patient that has large fluid chambers, doesn't necessarily have hydrocephalus, correct? Then they don't necessarily need a shunt?

It's a very important distinction and it's not always easy to answer or really clarify that distinction. So with the loss of any brain tissue, be it from injury, stroke, infection, the ventricles will compensate by getting larger. That does not mean that the patient has symptomatic hydrocephalus or raised intraventricular pressure. So again, the therapy is dictated based on very accurate diagnostic testing with a trained neurologist and/or neurosurgeon.

I'd like to take this opportunity to thank my guests, Richie and Jill. I think that they've been superb in terms of providing us with some insight about their experiences with endoscopic third ventriculostomy. And I'd also like to thank Dr. Mark Souweidane, the Director of Pediatric Neurological Survey at the Komansky Children's Health Center, New York Presbyterian Hospital, Weill Cornell Medical Center. I think in this past hour, I hope in this past hour, you have learned to

appreciate the complexity of the procedure using endoscopes to approach the third ventricles. But even beyond that, and I think that we would all agree that medicine is an art -- there is an art to medicine that requires experts like Dr. Souweidane to help you, the patient, and you, possibly the referring physician, determine who is a candidate for this very new innovative technology. It's a superb technology, minimally invasive, as we said, patients leave the hospital within a day. But it has be done on the correct patient. And when it is done on the correct patient, you get the beautiful results of somebody like Richie. So again, I appreciate you taking the time to be with us here on this session on minimally invasive access for the treatment of hydrocephalus. Thank you again.

Thank you for watching this OR Live Webcast presentation from the Phyllis and David Komansky Center for Children's Health at New York Presbyterian Hospital, Weill Cornell Medical Center. 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. OR Live, the vision of improving health.