00:00:12
ANNOUNCER: Welcome to Tampa General Hospital. Over the next hour you'll see a cochlear implant surgery to provide a sense of sound to people who suffer from hearing loss. During the procedure a small internal computer is implanted into the bone behind the ear. The surgeon opens the mastoid bone behind the outer ear to access the cochlea and slides an electrode cable into the inner ear. A microphone picks up sound from the environment and sends it to a speech processor that selects and arranges the sound. A computer then breaks down the sound into small bandwidths, or channels, that travel into the inner ear and are interpreted by sound in the brain. 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 go to the operating room.

00:01:04
CHRISTOPHER DANNER, MD: Good afternoon. Welcome to the OR here at Tampa General Hospital, a hospital named in U.S. News and World Report as one of America's best in otolaryngology ENT surgery. My name is Dr. Chris Danner, and today with me in the OR is my partner, Dr. Loren Bartels. Together with a group of highly trained audiologists make up the Tampa Bay Hearing and Balance Center. Dr. Loren Bartels and I both operate at Tampa General Hospital. We will be performing a surgery today that restores hearing to a person who is completely deaf. This miraculous surgery is done by inserting an electronic device underneath the skin and directly into the inner ear. This device is made up of an external component that shows -- that takes the sound from the environment and transforms it into an electrical signal, and this is transformed into an internal component that Dr. Bartels will be inserting today. What I'd like to do is now turn it over to my partner, Dr. Loren Bartels.

00:02:15
LOREN BARTELS, MD, FACS: Thank you, Dr. Danner, and good afternoon. If I can show -- our external processor sits behind the ear. We will put in an internal proc-- system in this location. This is where our incision will be. May I have the knife, please? And a small-angled Wheatlaner. We've put local anesthesia into the skin to decrease bleeding. That also makes the need for general anesthesia to be a little less. Bovie, please. Electrically coagulating blood vessels decreases our bleeding. Bipolar cautery, please.

00:03:27
CHRISTOPHER DANNER, MD: If you look here on the diagram, you can see where the incision where Dr. Bartels is making his incision, and this will create a pocket underneath the scalp for him to put the internal processor. And what he's --

00:03:48
LOREN BARTELS, MD, FACS: A two-prong hook, please.

00:03:50
CHRISTOPHER DANNER, MD: Now what he's doing is he's accessing the soft tissues to get access to the lateral skull, which is a bone right behind the external ear here.

00:04:04
LOREN BARTELS, MD, FACS: Bovie, please.
CHRISTOPHER DANNER, MD: The device he's using right now is a -- called a Bovie, and it uses electricity, or electromagnetic field to cauterize and cut tissue, and this minimizes bleeding.

LOREN BARTELS, MD, FACS: Let's have a [unintelligible] elevator, please. Now we will elevate some of the bone covering called periosteum. The implant goes underneath the scalp. The periosteum is the layer adjacent to bone, and if we can get this right in this layer adjacent to bone, that's where we'll have the best situation for the device. Now, this pocket is about 6 centimeters deep and about 3 to 4 centimeters wide. Let's have a 7 suction, please. Okay. Let's have the metal dummy now, please. This is a template of what the device we will be putting in, and we want to make sure that will go into position, and indeed it does. Now I'd like to mark the position that will be in. Let's have a marking pen. Now let's go back to Dr. Danner as I switch over to the microscope.

CHRISTOPHER DANNER, MD: Okay. Let's talk briefly about who's going to be a candidate for a cochlear implant surgery, specifically talking about adults. An adult must have severe or profound hearing loss in both ears. They must have become deaf after learning to speak, and the internal ear must be surgically accessible. Also, the individual must be in good enough health to undergo this surgical procedure. Children also can have this procedure done, and for children deafness needs to be less than 90 dec-- I mean, more than 90 decibels and the internal ear, or the inner ear, has to be surgically accessible also. With children and infants, the hearing nerve needs to be present. At some times, the hearing nerve is absent and that is the main cause of their deafness, and obviously putting in an implant will not help these individuals. What I'd like to do now is I'd like to talk to you a little bit about what these implants look like. This implant right here is what Dr. Bartels is going to be inserting underneath the scalp. This has an ex- this has a little magnet, as you can see here, that's underneath the scalp and you have an external device that will connect to this magnet and will allow the external antenna to stay motionless on the scalp. You have a computer system here that transmits the electrical signal down through an electrical array that goes into an inner ear, and this gets implanted up underneath the scalp in this position right here. After this is implanted, about three to four weeks after the implantation, the patient comes in and gets programmed, and they wear an external device like this that gets placed over the ear -- let's see if I can get this on here for you -- like this that has a -- this has an antenna and it has a magnet inside this antenna here. And this two magnets will clip together and will hold this antenna on the side of the scalp like this. And this will allow the external device to communicate with the internal device that Dr. Bartels inserts underneath the scalp. Okay, let me get this off here.

LOREN BARTELS, MD, FACS: Okay, we're going to drill in this location a pocket in the bone that we put the internal computer in. We've marked where that pocket will be using the template system. This pocket is probably about 3 millimeters deep into bone. Adjust that retractor just a bit and just ahead of it.

CHRISTOPHER DANNER, MD: If you look on the diagram over to the side of your screen, this is a cartoon showing the bony pocket that Dr. Bartels is drawing -- I mean drilling. And this is a surgical seat that will help hold the cochlear implant in place so it doesn't move after it heals. Let's go back and talk about the surgical steps of the procedure. First we need to establish general anesthesia. This is done with a patient that's completely asleep. We disinfect the skin by cleansing the skin with betadine. We also put a betadine-impregnated plastic shield that sticks down to the skin that you can see now on the surgical field. This also cuts down dramatically on infection. We inject a local anesthesia, which is lidocaine or other similar medication, underneath the skin. This anesthetizes the skin and decreases the
need for general anesthesia. It also decreases the bleeding. The way that anesthesia is performed here at Tampa General when we do these cochlear implants, there is a mask that goes around the voice box and prevents us from needing a tube being placed directly into the windpipe. The patient is breathing on their own spontaneously but is deep -- under deep anesthesia. This allows the patient to have a minimal need for general anesthesia, decreases the risk of any complications that may ensue from anesthesia, and allows the patient to wake up quicker and go home quicker after surgery. People that have this surgery will come in, they'll have the surgery done, which you will see takes a little under about an hour, and will go home the same day. They will come in approximately three weeks later and have their implant turned on and activated, at which time they'll hear.

LOREN BARTELS, MD, FACS: Okay. Let's adjust this army-navy to here.

CHRISTOPHER DANNER, MD: If you look on the diagram here, you can see a cartoon drawing of a person's head. And the dotted blue line is the internal device that Dr. Bartels will be inserting today. As you can see, the yellow circular device here, that's the computer system and activation system for the internal device. And it's fairly thick, and this is what the well that Dr. Bartels will be drilling to house this device. As you can see, the solid blue line coming down, this is the electrode array that goes directly down into the inner ear. This well that Dr. Bartels is drilling right now is very important and you need a very precise fit because it allows this canister to fit in a well drilled in the bone that prevents it from moving. By doing this, when you have a very precise fit, there's no need to actually sew the device into place.

LOREN BARTELS, MD, FACS: Okay, let's have the plastic now and see what our fit looks like. We're close. We've probably got another millimeter or two to go before we fit. Hemostat, please. Okay. Take that.

CHRISTOPHER DANNER, MD: Now that is a dummy device. It's basically a silastic replica of what the real implant is, so that way we do not have to open the real implant until we're exactly ready to implant it into the patient. So we can take this fake implant that just is a dummy to put in and out of the patient to assure we get a proper fit that minimizes damage and trauma done to the real implant. I'd like to go back and talk about candidates for cochlear implantation. We left off on children. This is an amazing surgery and an amazing technology we have, and when you can get a child who's deaf and implant them early, they will grow up and learn to speak and acquire language in a similar fashion as their peers. And if you can implant these in both ears by the time that a child is 12 to 18 months of age, they can have normal or near normal language development. They can participate in normal school activities, and as far as any bystanders would be conserved, they'll be completely normal hearing individuals. At this point in time, cochlear implantation is moving from implanting just one ear to implanting both ears. We can implant both ears simultaneously. By implanting both ears, this allows an individual to hear and localize sound. When someone is able to localize sound and hears in both ears at the same time, they are able to discriminate sound and can hear quite well with background noise. If an individual only hears well in just one ear, it can be quite difficult at times to under-- hear any background noise. Okay. Also, I'd like to remind our viewers that we are taking emails, so if you have any questions that should come up in the surgery, please feel free to email us your questions and we'll answer them directly here in the OR. Now if you look here at this diagram, this is a hole that's being drilled into the mastoid, which is an air cell pocket or honeycomb bone that's in the ear. And Dr. Bartels will be drilling this. And this will g-- this will allow us to gain access directly into the inner ear. What he's drilling right now is just a recessed well that will house one of the components to the internal device. It's just a thick plastic covering that gives more support to the cochlear implant and the electrode array.
LOREN BARTELS, MD, FACS: Roll the table away, please. Seven suction. We've now drilled the internal receiver inside as Dr. Danner has described. The next step is to open the mastoid so that we can have access to put the cable system into the inner ear. Right now we're looking for where the bony ear canal is, and that's the bony ear canal showing up there. Let's have the intermediate Wheatlaner now, please. And let's have the largest cutting burr. Now, through a fairly small incision, usually about an inch and a quarter, we're able to get in, and this is called limited access surgery. Let's have a 10 suction, please. This hole in the bone will be about 1.2 centimeters from front to back, or anterior to posterior, and will be about 1.5 to 1.8 centimeters in a vertical dimension. Now, these little pockets that we're opening into are called mastoid air cells. Let's have the 10 suction, please. In effect, they are small sinuses. They sit in the bone behind the middle ear and behind the bony ear canal.

CHRISTOPHER DANNER, MD: Just to put things in perspective, that round burr that Dr. Bartels is using to open up the ear and drill the bone away is about 6 millimeters in diameter. A millimeter is about the thickness of a dime. So if you were to stack six dimes on top of each other, that's about how wide that burr is. So it's -- the bony opening that he's making is a little over about a half an inch to three-quarters of an inch wide, maybe about an inch, inch and a half long.

LOREN BARTELS, MD, FACS: Now, let's go to the next to the largest aggressive diamond, please. Roll the table away, please. This blue area is a vein that drains the brain called the sigmoid sinus. This air pocket that we are about to open into here is called the mastoid antrum. We will be looking through the mastoid antrum to find one of the balance canals called the lateral semicircular canal. That balance canal tells us approximately where the second hearing bone, the incus, or the anvil bone, is located.

CHRISTOPHER DANNER, MD: If you look over here on the diagram to your right, you can see the bony defect that Dr. Bartels is making. You can see a representation of the vein that he was referring to earlier. If you look at the diagram here, you can see the bony opening that he is going to create. This window in the bone he is making will allow the placement of the electrode array, or electrode cable. We just -- this is an email that we just received. The question says, "When considering bilateral implants, is there a new technology on the horizon that may be precluded -- that may preclude a current cochlear implantation?" At this point in time, the internal device that we're putting into the patient is a relatively simple by design and it really doesn't get updated very often. Most of the updates that are done are done with the external device, which is easily done because there's no -- there's no surgery needed to help make the -- any upgrades. Do you have any comments, Dr. Bartels, on this email?

LOREN BARTELS, MD, FACS: Yes. The internal systems are made with a great deal of computer plasticity. In other words, there's a great deal of potential for these devices to be programmed in ways well beyond and well more complicated than the current speech processors are capable of doing. So the companies that make these devices are well aware that the external systems that Dr. Danner mentioned will improve over time. Those improvements will largely be new theories about how to make sound through a cochlear implant sound more normal. Let's have a next size smaller diamond, please. And a gimmick while we're changing.

CHRISTOPHER DANNER, MD: Right. Now, what Dr. Bartels is doing right now, he's developing a window between two nerves inside the inner ear. If you look on your diagram on the right, there is a nerve called the facial nerve, and this nerve is used to move the face.
It makes you smile, your eyes open and close, and for you to raise your eyebrows. Above this nerve, above this opening that he is creating, there is a nerve that is involved in taste. It is involved with sweet, sour, and bitter and salty taste in the right side of your tongue. And you drill a bony opening or window between these two nerves to get access to the space to put in the electrode cable.

LOREN BARTELS, MD, FACS: Turn the irrigation down to 15.

CHRISTOPHER DANNER, MD: There's another email question that shows -- it asks, "How uncomfortable is the patient in the days following surgery?" People tolerate this procedure very well. They are obviously going to be a little sore after surgery, but often patients do not even fill their narcotic pain medicine and are able to manage with just Tylenol after surgery. But people are a little sore for a day or two after surgery. Sometimes they can be a little off balance, but this is minimal. It usually self-corrects within 24 to 48 hours. And by the time they're about a day or two out from surgery, people are doing quite well. There was a gentleman that we operated on just last week that I saw today that he said after his surgery that he went out to dinner with his wife. And so he, you can imagine that he was doing quite well after surgery.

LOREN BARTELS, MD, FACS: Now, what we've identified here is the nerve that makes the faces smile. Right in here we're identifying the nerve of taste. This is an air cell, a mastoid air cell. We follow this nerve of taste into the middle ear. Let's have a gimmick for a moment, please. And a next size smaller diamond, please. Now as we follow this in, this is - - this is the second hearing bone, called the incus. This is the third hearing bone, called the stapes. The incus bone joins the stapes in this location. And our goal at this point is to get into this area where we will see the round opening into the inner ear. Ready?

CHRISTOPHER DANNER, MD: There's another email question. This individual is asking, saying that they have severe hearing loss; they cannot hear daily conversation or telephone conversations. Even using the most advanced hearing aids, they are still having a quite difficult time understanding speech. This person is 69 years old and is asking questions about whether they would be a candidate for this surgery and about particular cost involved. The -- a good general rule of thumb is who would be determining specifically who or who would not be a candidate for surgery is whether they're able to function well with hearing aids. If they're using the most advanced hearing aid technology and still having a difficult time understanding speech and really are relying more on lip reading than anything else, then that's a good general rule of thumb that that individual would benefit from a cochlear implant. As far as age is concerned, age in and of itself is not a contraindication for surgery, more on the patient's general health. So we can have an individual we've put implants in that are well over -- I guess -- who's the oldest person that you have implanted, Dr. Bartels?

LOREN BARTELS, MD, FACS: The oldest I've done, I think, is 83. Let's have the 2 millimeter cutting burr, please.

CHRISTOPHER DANNER, MD: So, and these people tolerate the procedure quite well. And it's really minimal surgery and people do quite well with it, so I wouldn't let age in and of itself be a limiting factor. The cost of the procedure can be quite expensive, and these are generally covered by insurance, but the cost for the implant can range in upwards of over $20,000 for the implant itself, and then surgical fees on top of that, which are a few thousand dollars. Do you have anything else you'd like to add to that question, Dr. Bartels?
LOREN BARTELS, MD, FACS: Medicare covers both unilateral and bilateral implants. Medicaid will cover putting in a cochlear implant. Vocational rehabilitation will cover it. And almost all insurances now cover cochlear implants in the United States. This is a groove that we’ll put the cable in so that it goes from the internal receiver site into the mastoid. Okay. Ball syringe. Okay. Let’s have the Skeeter drill now, please. With a 1.3 millimeter diamond.

00:30:38

CHRISTOPHER DANNER, MD: I’m answering some more email questions. This question states, “Why is the risk of meningitis greater in people with cochlear implants?” That’s a good question. The reason is, is because we’re drilling directly into the inner ear, and the inner ear has a more direct access to the covering around the brain. Now, the risk of increased meningitis is really not substantial, and even this minimal increased risk of meningitis is made smaller by putting a seal around the opening into the inner ear. Dr. Bartels now is drilling a hole into the cochlea, or inner ear, and it will allow him to insert the electrode array directly into the inner ear. If you -- here -- if you look here on this diagram here, this red -- I mean, this white dotted circle will show the area that Dr. Bartels is drilling. And if you look at this new diagram here off to your right, you can see the electrode array and how it’s inserted into the inner ear. This other diagram off to your right shows how the electrode array gets inserted into the inner ear. This green dotted line shows the electrode coil or cable that gets inserted directly into the inner ear here and the hole that Dr. Bartels is drilling now.

00:32:45

LOREN BARTELS, MD, FACS: One millimeter diamond, please. Let’s have a joint knife, please. As Dr. Danner has described, we’re drilling past the stapes bone into an area called the round window niche. This bluish-appearing area is around window membrane of the cochlea. And just beyond this opening is a tiny, tiny channel that goes to the spinal fluid cavity called the cochlear aqueduct. And it’s likely along that pathway that you could get meningitis if the inner ear is not sealed. Now, the other thing that decreases meningitis risk is getting a vaccine. The current Center for Disease's Control strong recommendation is that everybody who has a cochlear implant should have a pneumococcal vaccine. The risk of getting meningitis is probably a bit less than 1 chance in 1,000, so it’s pretty low.

00:34:01

CHRISTOPHER DANNER, MD: Here's another email question. It says, "The criteria that you stated, that a person who is deafened prior to a speech development are not candidates for implant surgery as they will not benefit. Can't they benefit from awareness in the environment?" That's a true statement. The person who is what we call prelingually deafened, or someone who loses their hearing before they develop speech, doesn't perform as well as someone who is postlingually deafened, or someone who loses their hearing after they develop speech. Now, that does not mean that an individual does not benefit from a cochlear implant. Yes, they will be able to have sound awareness and environmental awareness. It's -- these individuals need to be counseled very well on what expectations they should have with their cochlear implant afterwards. These individuals who are prelingually deafened, or lose their hearing before they develop speech, will not achieve the ability to talk on the telephone and will not have normal hearing but will have awareness to environmental sounds.

00:35:36

LOREN BARTELS, MD, FACS: All right. Now I’m going to open the cochlea. We have developed an opening here that is a little -- about a millimeter front to back and about 1.2 millimeters in vertical dimension. All right, let's have the cochlear implant. All righty. We have the implant ready. This is the internal device. This is a magnet that holds the external antenna in place. This is the internal antenna. This is the internal computer. And then this is the cable that carries the electrodes to the inner ear. And the electrodes are these tiny little shiny things on the end of this electrode. This goes under the scalp and falls into that bony
pocket that I've drilled. The fantail cable will go through the bone in this fashion. Perkins to the left again, please. Now, inserter.

00:37:05

CHRISTOPHER DANNER, MD: There's another email question that says, "What is the expected lifespan of a cochlear implant?" Basically, for the life of the patient. There are sometimes with trauma just with normal daily activities, there is time when the implant becomes nonfunctional and needs to be replaced, but this is a small percentage of individuals.

00:37:36

LOREN BARTELS, MD, FACS: At present, the risk that the internal device will fail is also about 1 chance in 1,000. Twenty-four suction. Both companies have developed very high system reliability. Now, if you'll see there's a groove in this insertion device. The implant will come out of that groove and go into the cochlea. Dr. Danner in a moment will show you a diagram that shows how this coils inside the cochlea. Remember, the cochlea is snail-shaped. That's where the term "cochlea" comes from. Okay, all of the electrodes are in and we now have this. Let's have the 24 suction. And that is quite excellent. Strut guide, please. All right. Now, this little bit of electrode here is called a marker electrode. It's actually not an active electrode, it's one to mark how far in we put the device. Narrow two-prong hook, please. Now we'll take some tissue to seal the inner ear, just as Dr. Danner discussed. 15 blade. Sponge.

00:39:08

CHRISTOPHER DANNER, MD: If you can look over here you can see the diagram to your right that shows the tissue seal that will be placed around the electrode array and will plug off the hole into the inner ear.

00:39:21

LOREN BARTELS, MD, FACS: This tissue is called areolar fascia. It's a muscle covering. It has lots of fibrocytes in it. Fibrocytes generate scar tissue. Strut guide and a 24 suction, please.

00:39:42

CHRISTOPHER DANNER, MD: There no -- another few email questions we can run through real quick. "What percentage of people have balance problems after cochlear implant surgery?" I don't really know that anybody personally that has a persistent disabling balance problems after surgery. Some people will be mildly off balance for a day or two after surgery as they recover. Do you have any other specifics you would like to add, Dr. Bartels?

00:40:12

LOREN BARTELS, MD, FACS: There is a small percentage of people who have significant and persisting balance problems after surgery. It is uncommon. Sometimes physical therapy helps them. Looking here, now this is a well-sealed device. The -- many people who have cochlear implants have some balance problems be-- they've lost balance or function just as they've lost some of their hearing functions. So balance problem can occur. As Dr. Danner says, they can be troublesome for a few days after surgery. It's -- a few people have balance problems for a few weeks, and then a rare patient has balance problems that last a lot longer than that. Let's have the 3-0 -- the 2-0 polysorb, please. The implant is fully inserted now. We're going to close the incision. Our practice is to get an x-ray as soon as we're pretty well done with surgery to confirm that the implant is exactly where we want it to be. At this point, as beautifully as this went in, I don't have any doubt that the x-ray will look exactly the way we want it to.

00:41:30

CHRISTOPHER DANNER, MD: There's another email question that says, "Can you tell me if the bone stitches together after surgery?" That well that's drilled will slowly close in after surgery, but there most likely will persist a bony defect in that area. That's why we like to keep the bony defect to a minimum. And the way this is placed is actually where it's located
externally on the patient. They will actually fall behind the cartilaginous, or external, portion of the ear, so you really cannot feel any defects behind the ear. There's another question, says, "Where is the facial nerve located and how close is the drill to it?" The facial nerve is located right in that -- I'll kind of show you here on this diagram I think will make more of an example for you. If you look on your diagram over here to the right as Dr. Bartels is sewing this closed, you can see the dotted white circle, and the facial nerve is actually that lightened structure on the bottom portion of that dotted circle. So you're within a millimeter, and actually it can be exposed during the surgery. However, when you see this nerve, you stay away from it. And you can -- and it's very rarely injured during this surgery. And to help minimize any risk to the facial nerve, there is electrodes that are actually placed in the face of the patient after they go to sleep so we can monitor the function of this nerve. So if we get anywhere close to the nerve or have any trauma to the nerve, even the minutest minimal trauma, this monitor will alert us to that.

LOREN BARTELS, MD, FACS: In fact, in order to get to the round window membrane well, that facial nerve has to be very carefully exposed. It has to have very, very thin bone left over it or you really can't see well enough to do the surgery properly. There is a standard dictum, or principle, of ear surgery, and that is, the facial nerve is your guide to the ear. The -- one of the ways that we know where we are in the ear is that we find where the nerve that makes the faces smile is. Safe ear surgery always knows where that nerve is. So although that is a concern that we talk to people about before surgery, it's an extremely rare issue to have a problem with the facial nerve right after surgery. 4-0 polysorb, please.

CHRISTOPHER DANNER, MD: There's another email question that says, "I understand the surgery is through the eardrum. After the implant, will the natural hearing be there in addition to the implant? Actually, the implant is not through the eardrum. What we're doing is we're operating behind the ear canal and we are not even exposing the eardrum itself. The implant is placed underneath the eardrum. And in the process of implanting the electrode and we drill the hole into the inner ear, usually -- most of the time if not always -- any residual hearing the individual has is lost. This is why we implant individuals who no longer benefit from hearing aids. If they can benefit from hearing aids, the hearing that they have through using their natural hearing mechanism in their inner ear would be better than what can be achieved with the implant.

LOREN BARTELS, MD, FACS: There is some recent animal evidence that the loss of hearing with cochlear implant surgery might be preventable if there were a way that we could have steroids or cortisone-like medicine inside the inner ear for up to 30 days. And it may be that future implants will have the ability to slowly release steroids, and it may very well be that more patients will have some residual hearing after cochlear implant surgery. There are patients who have very good low-frequency hearing but very poor high-frequency hearing who are candidates for a very short cochlear implant electrode called a hybrid electrode. That is still in the experimental phases and we'll have to -- time will tell whether that implant system is one that makes sense.

CHRISTOPHER DANNER, MD: There's another email question, and he says, "How does ossification of the bone hinder getting into the cochlea or doing a cochlear implant?" Ossification of the inner ear does hinder it -- the implant. That's why, particularly for children who have had meningitis or other trauma, that could cause damage to the inner ear while the reactive process to the inner ear will cause the cochlea to scar in and bone to form. And this direct-- specifically inhibits us from implanting the electrode array. Depending on the amount of ossification, sometimes in patients with meningitis, the ossification, or bony formation, inside the lumen of the inner ear is relatively short. And if you can drill past this, you can insert the electrode array past this bony formation. But
people with ossification do not -- depending on the extent of the ossification, don't perform as well as if it was not ossified.

LOREN BARTELS, MD, FACS: If the ossification is severe, it can have an impact on how well the cochlear implant will work. And in some of those cases we have to completely drill the cochlea out and wrap the implant around the hearing nerve. And while that may not provide wonderful hearing, it typically does provide a substantial hearing benefit. Our experience is that most people with meningitis have limited ossification and they do very well with cochlear implants. The ones that have had severe ossification are the ones that are at risk for not doing as well.

CHRISTOPHER DANNER, MD: There is another email question. I think there was maybe some confusion on the answering when we talked about prelingually deaf individuals and postlingually deafened individual, or people that lose their hearing before and after they learn to speak. We're talking specifically about adults with this. Actually, obviously with a child, if they lose their hearing before they learn to speak, you can implant them and they do tremendously well. The earlier you implant a child who has prelingually deafened, or has been deafened before they learn to speak, the better they do. There has been studies that if you can get -- the earlier you can get the child implanted, the better their neural function will develop. And that -- there's a cutoff that we've found ends up being around three years of age that when a child develops, if there's no auditory stimulus, the nerves that take the information from your ear into your brain and actually process that sound are more or less highways, and those highways are developed if they're used. If they aren't used, then those highways don't develop as well in the person -- there will become a point in their developmental process where that developmental process cannot be reverse and turned back into a normal development. And that cutoff is around three years of age. So yes, children do quite well if they're implanted early and if they're prelingually deafened.

LOREN BARTELS, MD, FACS: Let me amplify on that a little bit. After three years of age, the processing speed inside of the brain will not get back to normal. Under three years of age, the processing speed for sound can get pretty close to normal if not perfectly normal, particularly if the implant is done around a year of age or a little earlier. Children between age 3 and age 9 clearly do benefit from cochlear implants. The ones that are implanted before age 5 get quite good language development, although they don't catch up with normal. Between age 9 and 12, the potential for a prelingually deaf child to do well with an implant is much reduced. However, there is an intermediate group of people, whether adults or children, who are severely impaired, have hearing aids, learn language, can speak fluently, and then go deaf. That group of individuals -- again, whether a child or an adult -- benefits very nicely from a cochlear implant. So one of the keys is in someone older than say age 4 or 5 is, is the content and the structure of their language normal? In other words, do they know nouns and verbs and can they put them together reasonably well? Those people generally do very nicely with cochlear implants. The person who is an adult who lost their hearing very early and cannot speak, cannot use language, does not have fluent verbal language, is less likely to do well with an implant. We strongly encourage children to have cochlear implants before two years of age and even earlier if we can know that. If a child, though, is severely impaired, using a hearing aid, we want that child to use the hearing aid as long as possible. When it gets to the point where the hearing aid is no longer providing adequate benefit, then doing a cochlear implant will work well regardless of whatever age that is. Do you have anything to add to that, Dr. Danner?

CHRISTOPHER DANNER, MD: No, that's great. We do have one more email question I'd like to address before we close, and that is whether skull growth affects cochlear implant in an infant who is implanted. Would you like to comment on that, Dr. Bartels?
LOREN BARTELS, MD, FACS: Yes. If you noticed when I put the cochlear implant in, it had some redundant coil tendency. Now, that's true in both children and adults. It gives us some flexibility in putting the implant in, but in children it also is a means to allow the skull to grow both in width and height without pulling the implant out of the inner ear. It is, in fact, quite rare for an implant to pull out of the inner ear because of growth. So skull growth is not a problem. Are there other questions?

CHRISTOPHER DANNER, MD: I think that's it. Well, this will conclude our surgery here at Tampa General Hospital. I'd like to thank you for joining us and watching this miraculous surgery, and I hope that you can benefit from the information that was presented today. I'd like to remind you that this video will be archived and available on our website for approximately a month after today's date. I'd like to thank you again for joining us today at Tampa General Hospital.

LOREN BARTELS, MD, FACS: Have a good day.

CHRISTOPHER DANNER, MD: Okay, I was corrected. This will be available -- the video will be available indefinitely on our website. So I'd like to thank you for joining us today from Tampa General Hospital and I wish you the best today. Thank you.

ANNOUNCER: This has been a cochlear implant surgery performed live from Tampa General Hospital in Tampa, Florida. 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.