HYBRID MAZE PROCEDURE
NORTHWESTERN MEMORIAL HOSPITAL
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ANNOUNCER: Welcome to Northwestern Memorial Hospital in Chicago, Illinois. You're a few moments away from an interactive discussion of the hybrid maze procedure. Atrial fibrillation is the second leading cause of stroke in the U.S. To combat this heart disorder, surgeons and electrophysiologists are combining their efforts in performing the hybrid maze procedure. This innovative, minimally invasive procedure places scar lines around the heart that isolate the electrical signals that cause atrial fibrillation. OR-Live makes it easy for you to learn more. Just click on the "request information" button on your webcast screen and open the door to informed medical care. Now let's join the doctors.
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RICHARD LEE, MD: Welcome to Northwest Memorial Hospital. My name's Dr. Richard Lee. I'm a cardiac surgeon here. And I'm surgical director of atrial fibrillation. We are here to talk to you about atrial fibrillation a little bit and to talk to you about one of the new treatments that we've developed here at Northwestern Memorial Hospital. With me is Dr. Patrick McCarthy. He is the surgical director of the Bloom Cardiovascular Institute. Welcome, Pat.
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PATRICK McCARTHY, MD: Thanks for having me here, Rick.
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RICHARD LEE, MD: Why don't we start with talking a little bit about atrial fibrillation. Many people have atrial fibrillation and they come to see their doctor for it. They have different symptoms that usually lead to their appointment. Oftentimes patients are short of breath or they feel like their heart is racing, and some patients even might feel light-headed or dizzy and pass out. But probably the most dramatic presentation of atrial fibrillation is that of stroke. And what we're going to cut to a video for a second to show you one of the main causes of stroke with atrial fibrillation. Atrial fibrillation is an irregularity of the upper portion of the chambers of the heart, called the atrium. And the atrium is uncoordinated, it no longer beats or squeezes, so blood tends to pool in that upper chamber. And when blood pools, clot is formed. Here you can see on the video -- what you saw on the video was a mitral valve surgery, and the hole was the orifice of the left atrial appendage. In there was clot. You can see what happened when we pulled the clot out of the atrial appendage. The thing that's kind of scary is, if we leave it in there or we don't do an open-heart surgery, it can break off and get out on its own. When it gets out, it actually causes stroke. We're going to cut to some slides. And you can see atrial fibrillation is the second leading cause of stroke in this country. It's especially scary in the elderly population. As you look, atrial fibrillation causes stroke in about 25 to 35 percent of patients in the 70 to 90-year-old range. Atrial fibrillation is also more common. This is a slide that shows the prevalence of atrial fibrillation in the United States. You can see that about 6 million people in this country already have it. As time goes on -- we all know that our population is aging, getting older. And as time goes on, this problem is going to get more and more severe. We predict that by the year 2025, probably about 10 million United States citizens are going to suffer from atrial fibrillation. Now, we do have options, though, and here what you're seeing is a

cartoon of a surgery for atrial fibrillation. And I was hoping Dr. McCarthy was one of the first people in the country to perform it with Dr. James Cox, the inventor of it.
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PATRICK McCARTHY, MD: This is a great operation. This is the Cox maze procedure that we're looking at here, Rick, in the slides. And I won't go through all the details of it because it's such a huge extensive operation. But in short, what the surgeon does is you go on the heart-lung machine, stop the heart, and you make these incisions in the atria. The atria are the upper chambers of the heart. And what it does is that the irregular heartbeats that are firing are suppressed. That's the atrial fibrillation. And so the electrical wave front travels down the normal pathway down this maze, we call it, like a maze of pathways from the upper to the lower chambers of the heart. And it was a very effective surgery, it works really well, but it's pretty complex. It really didn't catch on much across the United States because it took quite a bit of time, especially if you were adding it to other heart operations. I just want to also take this time to remind the viewers that this is a live program and they should feel free to email us if they have any questions as we go through this. After Dr. Lee shows some of the surgical video, we're going to come back and answer those questions from the audience. Rick?
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RICHARD LEE, MD: Thanks a lot, Pat. And also, for those of you who are doing this for CME, please stick around afterwards and answer the questions for CME credit. Well, you know, one of the things that we learned from Dr. Cox's group is the maze actually was very effective at reducing stroke. What I'd like you to see now is a slide of the success rate for preventing stroke after the maze operation. Now, what that means is this: Dr. Cox operated on about 245 patients and followed them up over a decade. You can see the upper lines is the risk for stroke in this population. Some people are at a higher risk for stroke depending on their age, depending on whether or not they had previous stroke or whether or not they are on blood thinners. Around the red circle at the bottom is what you see the number of strokes that actually occurred after the maze operation. And the majority of these patients were off their medicines and they no longer were taking blood thinners. So this is in some ways a big surprise to see this much reduction of stroke, and we feel this is probably one of the biggest benefits of the maze operation. Well, why don't we break down what the maze operation is -- or was -- and what we're doing here at Northwestern.
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The analogy I like to give is the atrial fibrillation is an irregularity, a failure to have the impulse go from point A to point B. And if you had a -- what I like to share with patients oftentimes is if you had a lake in the morning, a crystal pond, and threw one rock in the middle, that would be sinus rhythm. The rock would hit and the wave would spread out, and that's the way it's supposed to happen. Now, if you took that same pond in the morning and took 100 rocks and threw 100 rocks in the middle of the pond, you'd have chaos. You'd have each one having its own circuit. What the maze is designed to do is form scar in little areas of the heart that force that impulse from point A to B through a maze of scar. And if we go back to the slide, you can see on the left side of the maze there is a scar around the pulmonary veins. Those are where the circles are in the center of the heart. And you see the left atrium, you see the mitral valve and the circles of the pulmonary veins. So there's a scar that's made around the pulmonary veins and then one scar that connects to the mitral valve, one that connects the atrial appendage, and then one that takes off the atrial appendage. Now, what we've done here at Northwestern is divide that up into two so that we can do this with a beating heart without opening the patient's chest or without going in the heart-lung machine. In stage I, which is a procedure many of us have performed around the country, we isolate the pulmonary veins and have two islands of scar. In addition, we take off the left atrial appendage. Now, this works for some people, but especially for people who are on atrial fibrillation all the time, it's not as effective as we would like. What do we do next? Well, in stage II, if a patient still suffers from atrial fibrillation, about a month or so

afterward we make the connecting lines from a catheter-based approach or a groin poke. You can see now we've added those lines down to the mitral annulus and connected those two big circles around the pulmonary veins. This gives us a maze without opening the patient's chest. What we're going to focus on for mostly today is the first stage of the maze, first stage of the hybrid maze, pulmonary vein isolation and left atrial appendage ligation. And we have video footage of it we can go to right now.
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PATRICK McCARTHY, MD: So to summarize, you're taking the complex maze procedure and then you're going to break it down into these smaller parts, do a lot of it through these very small openings, these ports, and then at a later phase you'll be able to add the more complex internal parts. But essentially you create the same operation.
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RICHARD LEE, MD: That's correct. And here is the first stage of the operation. You can see to perform this operation you need to have thorascopic guidance. So about halfway down the chest we make a small incision and put in a camera. Then from the inside we see where we would want to go from the outside in. You can see about the third interspace means about the area between the third and fourth rib kind of underneath the arm we make a small incision. The incision is only about three finger-breadths long. And this shows it from the inside. In the inside you can see the lung. We've deflated the lung. You can see the incisions here. And it looks a little bigger than it is. You'll see when we go back to the outside.
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PATRICK McCARTHY, MD: This is the view from that first scope that you put in, and then you're looking through the scope now at that incision, that small incision that you placed.
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RICHARD LEE, MD: That's correct. And it takes a little while, but --
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PATRICK McCARTHY, MD: Is this patient a smoker? The lung looks like it has those little black marks on it instead of the perfect pink view?
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RICHARD LEE, MD: Fortunately, this patient is not a smoker. Many adults, and many adults like us that live in the city, do develop little black spots on the lung. They're not dangerous or indicative of anything bad. You can see about three fingers or so go in. Now, the next step we do is take a soft tissue retractor. One of the nice things about this procedure is we don't have to break any ribs, we don't spread any ribs, and we don't break any bones. But in order to see through there, we kind of need to get the fat and the soft tissues out of the way. So this retractor is quite useful. It just pushes the tissue out of the way so we can see inside. We performed some of this operation using the scope and looking from the scope, but some we performed through this little incision.
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PATRICK McCARTHY, MD: So it's hard for the viewers. This would be over near the side of the arm. This is the right side at this point?
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RICHARD LEE, MD: This is the right side. We start with the right side. Usually the patient is left side down, right side up, and their arm's kind of above their head.
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PATRICK McCARTHY, MD: So the patient's under general anesthesia, sound asleep, and turned a little bit on his side. And so you're now looking in sort of underneath the right armpit.
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RICHARD LEE, MD: Absolutely. And this retractor once again is just in the fat above the ribs. You can see we can get a lot of nice big exposure through that incision yet not break or stretch any ribs.

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PATRICK McCARTHY, MD: Do you have to go on the heart-lung machine to do this operation?
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RICHARD LEE, MD: We do not, actually. If there were a complication, we could do that to help us out, but in general we never go on the heart-lung machine for this operation. Now, the first step you can see is to open the lining around the heart, the pericardium. The pericardium is just kind of a sac with a little bit of fluid around it. One of the things we have to be very careful of is to watch out for this phrenic nerve. This is the nerve that enervates the diaphragm. It makes your diaphragm go up and down. And you can see we're pretty far away from that, but we're very cautious about not injuring that nerve to the diaphragm. Right here underneath it you see the right atrium. The heart's beating obviously, and that's the right atrium. That's the chamber that gets blood back from the body before it goes to the lungs. Up here you see the superior vena cava underneath. That's the big blood vessel that drains the head and the arms. Next, after we open up the lining around the heart, we put in these little pericardial stay sutures. That is, sutures that kind of give us traction to pull this out so we can see the areas that we really need to visualize well. You see the view in the lower right from the outside and the view from the inside with the camera. Now, in order to retract this we don't make another incision, we just put kind of a big needle through the skin and then grab the sutures and pull it to the side.
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PATRICK McCARTHY, MD: So Rick, some of the patients seem to know about the catheter ablation. The difference between this and catheter ablation is you're on the outside of the heart, in between the scope and just looking through that small incision, you're actually looking at the heart instead of using radiation like they do in catheter ablation and then looking at a screen with fluoroscopy or scans and so on.
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RICHARD LEE, MD: Right. We clearly can see exactly what we're doing with this approach, but the main reason why we designed it is the catheter-based therapies do have a role in the treatment of atrial fibrillation, and they're quite good. However, they do have limitations, and I think there are advantages we have in surgery. That's why we split the procedure up into half the surgical and half catheter-based approach. Before I go on, though, I'd like to show you where we're at. Many people know that these are pulmonary veins. These are blood vessels that drain blood back from the lungs to the left side of the heart, and this is one of the areas that often produces atrial fibrillation. And catheter-based strategies are designed only at those areas. What we do is we isolate those areas electrically, and these are the circles that you saw on the maze procedure before. Can you stop the video for just a second? So what you saw was the beating heart, and then you saw us putting a white tip on it. What that white tip does -- you can see it from the outside right now -- is it emits electrical impulses, or pacers. It's like a tiny pacemaker. And we pace those pulmonary veins and show that electricity crosses into the atrium itself. You can start it up again. The reason we're doing this is to make sure that we know after we created a scar that a scar has been made and isolated. In addition, we look for areas of active autonomic enervated tissue. Now, the next step here, we create a little hole just in the tissue around the inferior pulmonary vein, or lower pulmonary vein, and the upper pulmonary vein. This is a lighted dissector. We need to get around the pulmonary veins to create this area of scar, that island that you saw on the pictures. Just to get a sense of where we want to go and how far it needs to be, we lay the dissector on top of the pulmonary veins. Now we insert it in a little space that we've created between the inferior vena cava, the blood vessel that drains the lower half of the body, and the pulmonary veins. So here are the pulmonary veins. We put the dissector in below the inferior pulmonary vein, and then we look for it to come above the pulmonary vein, where you see there. Now, we do this very carefully, but we dissect and get rid of the tissue, just the loose tissue over it. The light on the dissector makes it a

lot more safe for us because we can see the light and we know we're not in an area that we don't want to be in -- for example, in the heart. Once we get this, we free it up from all tissue.
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PATRICK McCARTHY, MD: So the light is sort of a lighthouse. It kind of guides where you start putting your instruments and where you dissect the tissue away so that you're not inside the pulmonary veins, you're on the outside of them.
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RICHARD LEE, MD: That is a great way to put it.
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PATRICK McCARTHY, MD: And the pulmonary veins are where most atrial fibrillation arises, so the crux of what you're doing is you're going to isolate those pulmonary veins, like the maze operation used to do, but instead of using scissors and actually cutting the heart, you're going to use these tools for ablation.
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RICHARD LEE, MD: I think that's one of the reasons why the maze was not as popular even though it worked when it came out. It was not only complicated, it required you to cut open the heart. And as you know, I spent a couple years in Dr. Cox's lab, where we were looking at other ways to make these scars without cutting it. This is bipolar radiofrequency ablation. It's one of the multiple other alternative methods used to create scar, but it's probably the most effective on the beating heart. What you see here is a wire that we placed outside the dissector, and we're attaching a guide to it. What this is going to do is just pass this guide underneath the pulmonary veins so that we can safely glide the ablation tool around the back of the heart. You can see the guides coming up to the dissector. And we'll gently pull this underneath, around the back of the pulmonary veins, in that space that we've created.
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PATRICK McCARTHY, MD: So in the operating room, sometimes you're looking up at a TV screen, in a sense, looking at the view that we see here, and then other times you look through that small incision directly at the heart and to see where the tools are going. So there's no visualization system like there is -- like an MRI scan or CAT scan or anything required for this.
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RICHARD LEE, MD: No, there's nothing else required except the tools that you see here and your own eyes.
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PATRICK McCARTHY, MD: Okay.
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RICHARD LEE, MD: Now what we've done is passed this guide around successfully. And we bring it outside the body. It does require a little bit, though, as you suggested. You need to work inside and outside the body in order to be able to do this, but what we have here is the bipolar clamp, the device we're going to use to put around the pulmonary veins to create an island, and we attach it to the guide.
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PATRICK McCARTHY, MD: And bipolar is referring to there's two jaws on this clamp, and then you'll clamp the tissue, and the electricity passes between the jaws, correct?
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RICHARD LEE, MD: That's correct. That's one of the nice things about this type of energy source is the energy goes just between those jaws. Some of the other energy sources that have been used in many different approaches, the energy just goes in one direction and it kind of spreads out. Sometimes it goes exactly as far as you want it to go, sometimes it goes a little too far, and oftentimes it goes not far enough. When it goes not far enough, that means that pure line, a scar, that wall scar is not created, and that means it's likely to fail. And the patient's most likely going to suffer from atrial fibrillation.

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PATRICK McCARTHY, MD: So there's a variety of ways to do this. You can heat it and burn it, in a sense, but also you could freeze it or you could make incisions or use ultrasound or microwave, correct?
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RICHARD LEE, MD: That's correct. Do you want to pause here for a second on the video? You can see this is the upper jaw. Underneath here was the lower jaw. And the energy goes back and forth in between these jaws. This creates the lesion, or the line of scar. And you can get a sense of that here along the line. Now, if you had the energy going just from here without a back wall, it would zap it, but regardless of the energy source. Sometimes, as I said, it would go all the way through exactly as you want, sometimes it would go too far, sometimes not far enough. What we're doing now is we're applying this pen to the pulmonary veins again. The reason we're doing this is we see this scar but we want to make sure that the electricity here does not go across into the atrium. Why? Well, if there's no wall of scar here, if this is not a wall of scar, then -- and there's a gap, for example, then abnormal impulse can fire across and get through the wall. Why is this bad? Well, this will cause atrial fibrillation. You can go ahead and run again.
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PATRICK McCARTHY, MD: Have you already done the ablation here, Rick?
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RICHARD LEE, MD: Yes, we've already done the ablation.
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PATRICK McCARTHY, MD: How long does it take to do the ablation?
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RICHARD LEE, MD: Well, this was real time in terms of the time it took for the ablation, so longer than our conversation. Usually it's about 30 seconds or so for each burn, and we oftentimes make a couple burns just to be on the safe side.
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PATRICK McCARTHY, MD: And if you were in the cath lab and you were only applying the energy from one port or one side, how long do you think it would take to isolate that set of veins there?
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RICHARD LEE, MD: Well, the -- in the cath lab, they can only have the unidirectional energy source, and they do it point by point by point. So it really is a long, long procedure to create all those scar lines. It would take several hours to do what we just did.
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PATRICK McCARTHY, MD: Instead of 30 seconds.
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RICHARD LEE, MD: Now, in this next -- you can pause again. One of the things that has been evolving in our understanding of atrial fibrillation, it's not just these pulmonary veins, we think, but we think this tissue around the pulmonary veins has little islands of nervous tissue, and these nerves can be good for sometimes, but sometimes it can be bad, too. They're bad when patients have atrial fibrillation. And we're looking for the rogue nerves, or the bad nerves that cause atrial fibrillation. When we find them, if they're outside of our line, we actually ablate those as well. Can you roll it again? And these are called autonomic ganglion, or ganglionic plexi.
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PATRICK McCARTHY, MD: You can see a little burn mark there, too, where you had applied the ablation energy near where you're testing right now.
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RICHARD LEE, MD: Sure can.
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PATRICK McCARTHY, MD: So the location anatomically is the pulmonary veins, but the underlying reason that people go into atrial fib, in some patients, the key may be that little yellowish fat pad that we were looking at around the veins, that that's where the triggers are.
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RICHARD LEE, MD: And there was recently an article published in a major journal in circulation to suggest that in fact there -- these autonomic ganglion, or this nervous tissue, may play a lot larger role than we previously thought, even in paroxysmal atrial fibrillation. And here you see the pericardium, the lining around the heart. We close this after we're done.
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PATRICK McCARTHY, MD: So you're finished with the right side here.
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RICHARD LEE, MD: We're done with the right side. All that we've got to do is close things up.
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PATRICK McCARTHY, MD: And those orange wires that you just placed?
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RICHARD LEE, MD: Those are temporary pacemaking wires. We don't use them very often, but we use them after all cardiac surgery when we use the heart-lung machine. But with this, occasionally we want the heart to beat a little faster, so we put these wires in the pericardium, then they rest on top of the heart. We can pace afterward, if need be. Or make the heart go as fast as we want. We do put a drain in, a small drain, and leave it in for a few days. And then we close up, and we're done with the right side.
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PATRICK McCARTHY, MD: So you're about halfway through.
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RICHARD LEE, MD: About halfway through.
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PATRICK McCARTHY, MD: And patients after all sorts of heart operations -- valve operations, anyone with atrial fib -- once you take away the atrial fib, frequently they will develop a slow heart rate. Sometimes medications like a drug called amnioderone may cause it and sometimes it's because their own heart's pacemaker has been in a sense sleeping for years or however long they've been in atrial fib. And so it's -- that's why you leave the pacing wires.
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RICHARD LEE, MD: That's why we do the temporary pacing wires, but in general, long-term we haven't really had many people go on a permanent pacemaker like we have after the maze. I think after the full maze, about 10% to 15% of patients end up needing permanent pacemakers. In our series -- I put together a series with two of my colleagues, Eric Byer, who's in Houston, Texas, and B.K. Lamb in Ottawa, Canada, and in our first 100 patients, we really only had one person go on to need a pacemaker after the stage one of this procedure.
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PATRICK McCARTHY, MD: Great.
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RICHARD LEE, MD: Should we go on to stage two? So at this point -- we can go on now -- at this point in the operation room, what we do is we close up, then we turn the patient on their side. We put the right side down and the left side up. And the breathing tube, start inflating the right lung and deflate the left lung.
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PATRICK McCARTHY, MD: So in a lot of ways, this will be mirror image, just doing the same procedure over on the left side.
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RICHARD LEE, MD: This will be very similar. There is a little difference. Again, we're -- we're doing the incisions in the same location. It's about the third interspace. We put the camera port about halfway through on the chest. And it's a very small incision, only about three fingers long. There are some differences on the left side, and we'll go over them as we face them in the video.
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PATRICK McCARTHY, MD: We've had some questions from some of the viewers about the recovery, but we'll be talking about that more afterwards, or is this a time that you want to talk about that?
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RICHARD LEE, MD: Oh, sure. We can do that now. In general, the majority of our patients go home after about four days or so. The only bad thing you can imagine, some of the patients do have some pain because it's like getting stabbed in the chest. But now with the -- we didn't show you we put pain pumps in all these patients that infuse pain medicine 100% of the time for the first couple of days. We also give them a pump that they can choose when they have pain, that they get a shot of medicine to alleviate it. But usually by the time they go home they're feeling pretty well. And because we don't divide the sternum or break any ribs, by two weeks they're back to their old self and back to full activity. Again, what you're seeing on the video is we've opened in the third interspace in between the third and fourth rib. We put in the soft tissue retractor. This side looks like it's a little bit smaller of an incision.
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PATRICK McCARTHY, MD: There's more information about this and atrial fib on our website, right? For the Bloom Cardiovascular Institute. And that's heart.nmh.org, which is where people can go to learn a lot about atrial fibrillation. But also, frequently it's associated with valve problems, patients with a leaky valve such as a mitral valve or patients that need coronary bypass or that have had a heart attack. So we'll see it in a variety of different conditions.
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RICHARD LEE, MD: And that's a great website, that's a great resource for patient education. I know I learn stuff every time I go to it. I agree, though. Oftentimes -- I'd say probably 20% of the time, the patients coming to me for this operation, they need something done, but they don't need this operation. They end up needing an additional operation like a mitral valve repair or a coronary artery bypass. So on the left side you can see we're pushing the left lung out of the way. That's why it looks a little different. Here is the phrenic nerve on the left. We actually go below the phrenic nerve on this side instead of above it. We're cutting into the pericardium again, and you can start seeing the left superior pulmonary vein. We place our retraction sutures in, just like we did on the right side. And here you see the view of what I see outside of the body, without the camera.
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PATRICK McCARTHY, MD: We're going to talk a little more later about what are good indications to do this in patients now, but one of the emails we've had from the viewers is a patient apparently has a clot inside their heart already, similar to what we had shown. And that's not a good patient for this, correct, Rick?
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RICHARD LEE, MD: That's correct. Generally, we offer patients with clots, if they had a clot and it went away, they're actually great patients for this operation. If they had a clot and it's still there, generally we try to put them on blood thinners for three months. If they had been on blood thinners for three months and still have a clot, they would not be a candidate for this particular operation, but we could do a minimally invasive approach on the heart-lung machine for atrial fibrillation, but that would be a different approach.
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PATRICK McCARTHY, MD: Other questions that we're getting, obviously people are very well informed these days with the Internet. People understand that this is very similar to other operations, but what's specific to what we're talking about today is the hybrid approach. So this is the first stage, and there's a second stage that's in the catheter lab where they do ablation as necessary, but just the simple, easy lines.
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RICHARD LEE, MD: Can you stop the video here for a second? Yeah, absolutely. This is -- the nice thing is we're not doing anything new here in terms of we're not inventing new procedures. What we're doing is we're taking existing, accepted procedure that are performed already across the country and across the world. But instead of taking and doing the same thing, we're taking what's best out of each of those different procedures -- one with our electrophysiologists and one with our cardiac surgeons -- and then combining them. So we take the best of both the procedures being offered currently and put them together to create the whole maze. That's what's unique, and that's what's being done here that I don't think is being done at other places at the present time.
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PATRICK McCARTHY, MD And there's a question about how many years we've been doing this first phase of that procedure.
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RICHARD LEE, MD: The first paper was only about four or five years ago. I've personally been doing this operation for about three and a half years. Can we roll again on the video? And here on the video, as you suggested before, Dr. McCarthy, the steps are all very similar. You can see we're pacing again on the pulmonary veins because we want to make sure that the electricity conducts across it. Or if you're in atrial fibrillation at the time, at least we can sense or measure that there's activity in the pulmonary veins coming from the atrium. After that we apply energy at a high frequency to specific areas, looking for those autonomic ganglion, or the bad nerves that we think contribute to atrial fibrillation. Once we've identified those, we start dissecting and freeing up some of the tissue that we want to place that lighted dissector around.
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PATRICK McCARTHY, MD: So essentially, you're going to do the same ablation to the left-sided pulmonary veins here, but then on the left we'll get to see you close the left atrial appendage, correct?
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RICHARD LEE, MD: Absolutely. That'll be towards the end of the procedure. You can do it pretty much any way you want. Now, this is what I had been waiting for. What my pickups here have is an area thick, fibrous, fatty tissue. This is called the ligament of Marshall. This is an area that has a tract of nerves that feed the heart and regulate its impulses. We divide that ligament of Marshall during this part of the operation. And we've actually done research here at Northwestern, Drs. Kadish, Goldberger, and Dr. Arora have shown that that area alters the signals of the heart. And I think it's critical to use this and divide that area as part of the maze operation. We've done that here, and we do that every time we do a procedure with minimally invasive maze.
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PATRICK McCARTHY, MD: As you do parts of it, even before we started to understand the implications of how important that was, it was part of the procedure anyways, even with the maze, because it was essentially in our way. So we ended up dividing the ligament of Marshall as part of that procedure.
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RICHARD LEE, MD: And that's what I think is interesting as we're learning more and more and more about the maze operation. There are several components that are clearly important in restoring sinus rhythm, but as we learn more, I think this denervation is becoming an important part of the maze operation in the traditional approach. And as you

said, I think if we're going to try to duplicate the maze with small incisions and a catheter-based approach, it requires that we also mimic and do the denervation to an equal extent.
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PATRICK McCARTHY, MD: Question about how long this procedure takes.
00:35:12
RICHARD LEE, MD: From start to finish, I'd say it takes about four hours, but a lot of that is prep time and putting the patient to sleep. And we unfortunately need two setups at the present time, where we prep and drape one side and then turn the patient and prep and drape the other side. The meat of the operation takes a little longer than you see here, but each side is about an hour or so. For each side.
00:35:39
PATRICK McCARTHY, MD: So a little over two hours to actually do the surgery, but anesthesia time and so on, it creates total of about four hours in the operating room.
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RICHARD LEE, MD: You can pause here for a second, because this is a nice view of the anatomy. Here is your left superior pulmonary vein. Here is your left inferior pulmonary vein. Again, and you can see the lung here. These are the blood vessels that drain blood after it has oxygen from the lung into the heart, into the left atrium. And this is where we want to create that line of scar. If you create a line of scar here, you can get narrowing of these pulmonary veins, and that actually was one of the problems with some of the earlier approaches. But by creating this line of scar where we are, it's outside these pulmonary veins and we can't really get narrowing.
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PATRICK McCARTHY, MD: So the narrowing or blockage of the pulmonary veins that you referred to earlier, that was catheter-based approaches, right?
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RICHARD LEE, MD: Yeah.
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PATRICK McCARTHY, MD: But I've never heard of that with a surgical approach. Again, because we're just looking right at it, and so we know that we don't put the ablation lines on the pulmonary veins themselves, we actually put them on the atria.
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RICHARD LEE, MD: And one of the other advantages, as I said, is with the energy that we use, the energy only goes in one place. It doesn't go further than the lower jaw. And you can run the video. And that, I think, also caused problems in the past. What you see now is we pass this lighted dissector again around the back of the heart. And there is really not much attachment on the pulmonary veins inferiorly on the left side. But again, the dissectors are on the back of the heart. This was -- the left side is usually a little bit faster and easier. And you can see we had the light, and when I was looking from outside in, we safely get it through. And so now that dissector goes around the back of the pulmonary veins, still inside the pericardium. But we pass the wire again. The guide is attached to the wire on the outside. And then we bring the wire back down into the chest. You can see the outside and the picture-in-picture and the inside on the main screen. Attach it and gently pull that dissector around the back of the pulmonary veins to give us a track for the lower part of our jaw.
00:38:23
PATRICK McCARTHY, MD: Question coming in, Rick. This may not be the time to talk about it. Why do you do this in two separate phases instead of doing it all at the same time in the operation room?
00:38:34
RICHARD LEE, MD: That's a great question, because a lot of people talk about doing it at one stage. And we talked about it here when we first developed this idea. But you know, in that series that I told you about with my collaborators, Dr. Byer and Dr. Lamb? In those 100

patients, the pulmonary vein isolation, or stage one, didn't work for everybody, but it worked probably for a little better than half the patients. Or maybe even half the patients. If that's the case, we don't really need to do anything else in those people. We've already done the pulmonary veins and taken left atrial appendage. It's for the people that pulmonary vein isolation alone is not good enough for. And that group are really the ones that need to go on to stage two. So at the present time, it looks to be about half the patients, maybe even a little less than half the patients, will need both stages. That's why we don't do it at the same time.
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PATRICK McCARTHY, MD: And just as a reminder that we will be able to take further questions, so feel free to email any questions that we have.
00:39:43
RICHARD LEE, MD: Back on the video, you can see the clamp already has been attached to the guide. We've already inserted the clamp into the chest. And now we're using that guide to follow the curve in the back of the heart to get the lower jaw around the pulmonary veins. Now, we don't push, we go very slowly. We want to make sure it's a safe procedure. But once we're here we can open up the clamp. All the controls are on the outside of the body, and we're looking at this through the video screen just like you are here. Once we open it, we direct it forward and kind of tug on that guide from above and gently get it -- there you go -- so it's all the way around those pulmonary veins.
00:41:01
PATRICK McCARTHY, MD: Rick, people have seen the black dots on the lungs and they're wondering if smokers can undergo this procedure. Is that sometimes a significant problem?
00:41:12
RICHARD LEE, MD: You know, it's been a rare problem. Almost always smokers can undergo this procedure. First of all, I have to say, though, we all know that smoking is bad for you, and if you're actively smoking, you are at risk for not only maybe atrial fibrillation but certainly coronary artery disease and lung cancer. So I think we probably should not have smokers at all, but you know, I do understand it's something that's very hard to quit. So in terms of smoking and this operation, it's not a contraindication at all. And we think it does offer people a big benefit. Now, if your lungs are really, really bad, for example, if you're on oxygen at home or you have what we call severe chronic obstructive pulmonary disease, you may not be a candidate for the operation. You can pause the video. If you won't tolerate one lung ventilation, for example, so if your lungs are so bad that we can't deflate a lung, well, then we probably could not do the operation. Or if you had prior operations on your chest or your heart, we wouldn't be able to safely do this operation. You can run the video again. So what you've seen already is we've gotten around these pulmonary veins. Here's the lower jaw. The upper jaw's a little obscure. We've clamped, we've isolated it, and now we're pacing. And we can see that the impulse, we made a wall, and we know that now. The impulse gets blocked. We can't go across anymore. Again, if we made half of a wall and left a gap, just putting a little electricity here would pass through and pace the heart. Fortunately, we have that wall of scar and we've done our job successfully. Can we run it again? And we've determined that by the pacing, we've confirmed it. Again, we slowly, gradually get the clamp out. Now, there is a little bit of juice in the pericardium. And it's a little red, but you would have a very different picture if there were actually an injury to the heart. So the isolation is done. The only things left are the identification and destruction of the autonomic ganglion, and we're doing that now. We're finding those bad nerves and making sure that they don't cause atrial fibrillation. The next step is where we take the atrial appendage that we talked about. As I said, we think that -- the story we heard that there's clot in the atrial appendage is a common one, and we think the atrial appendage probably is a site of clot about 90% of the time, and it causes stroke about 90% of the time in patients with atrial fibrillation. It's a little out pocketing, and you can see it here. It's a little out pocketing in the left atrium.

00:44:25
PATRICK McCARTHY, MD: So now we're looking at it from the outside. At the very first video that we showed, we were inside the heart doing mitral valve surgery and saw that big clot. We know that there's no clot in this because during surgery and also before, you had done an echocardiogram to show that there's no blood clot, is that correct?
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RICHARD LEE, MD: That's right. You can pause here for a second. Part of the preoperative workup in every patient includes getting a surface echo at least, meaning that we're looking at the heart to see if it squeezes normally. If it squeezes abnormally, we would do further workup. And we're looking to make sure that the valve doesn't leak. If the valve leaks significantly and you have atrial fibrillation, then most likely we need to address that, because just doing this operation won't really help a patient with a leaky mitral valve. But in addition, in the operating room before we make any skin incisions, we again do a transesophageal echo, which is something that we do with every cardiac surgery here at our hospital. We put a probe down and look at the heart from the inside of the esophagus. This shows us if the valve is leaky at that point in time or if there's clot in the atrial appendage. If there were clot in the atrial appendage, we would stop the procedure. Can we go back to the procedure again?
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PATRICK McCARTHY, MD: And one of the questions that came in was about the mitral and tricuspid valve and the pressure differential, and if patients did have leaky valves and high pressures, then just doing this procedure likely wouldn't work, so they would need an operation to repair those valves as well.
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RICHARD LEE, MD: Right, and we would not offer this operation to a patient with a leaky mitral valve. But we still have a lot of people we can help who don't have leaky valves with this operation. You can see this atrial appendage. You can see it's kind of flimsy. You can almost imagine how blood is not going to empty out of there if atrial fibrillation is occurring and would form a clot. Now, we've stapled across it -- we've squeezed across there, and now we're firing a stapler across it. This is endovascular stapler. It's used for many procedures in not only cardiac but other surgery. And we fire it. It fires a row of staples and cuts at the same time. Stop for a second. And you can see this stock doesn't empty. If it's contracting and squeezing in -- if this squeezing in -- it doesn't light up very well, but -- and if this is squeezing in, the blood empties and goes back into the heart. If -- remember the analogy I gave you. If you have 100 rocks in here and you've got circles going all over the place, well, it's not going to empty, it's just going to sit there, and that's where clot forms. So that's why we take it out.
00:47:17
PATRICK McCARTHY, MD: Well, this is about the size and it looks about like your little finger, and so it's this narrow little outpouching. It looks a little like the appendix, too. So you can remove this without any adverse effects on the patient, remove that part of the body, correct?
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RICHARD LEE, MD: It absolutely is a lot like the appendix. You know, we know the appendix probably is helpful. And in normal conditions, I think the atrial appendage probably has some benefit. But when the appendix is abnormal or when you have appendicitis, no one argues that we should leave it in. I feel the same way about the atrial appendage. When you have atrial fibrillation, I think you ought to have your atrial appendage out.
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PATRICK McCARTHY, MD: Again, this would be a good time for people to send in further questions. We have several that actually work well with -- we have a last couple of slides where Rick was going to talk about indications and contraindications to doing this procedure. And also to follow up, there is quite a bit of information on the Northwestern website at

heart.nmh.org. And several of the questions coming in we see are from the Chicago region. And so also to follow up, that the Health Learning Center here in the hospital itself also has health educators and medical librarians that can help people if they want to find more information about atrial fibrillation, strokes, heart disease, they'll be able to point them in the right direction and help them with that. Rick, do you want to talk about who the candidates for this and when you would do it and when not? Because that's what -- of all these questions coming in, that seems to be the big question.
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RICHARD LEE, MD: Yeah, and I'll start with a little disclaimer. You know, every patient is different. We can't give you an answer who the right patient is. If you have atrial fibrillation, I think you ought to be evaluated by a team of physicians. One unique thing we offer here is we actually have an atrial fibrillation center and we have a clinic that it's not only a surgeon running and it's not only electrophysiologists, it's a cardiologist who is an electrophysiologist, sees patients with the surgeon, and we kind of go over all your options and let the patient choose what option is best for him or her. So there is no right answer for everybody, there's just a right answer for each individual patient and for you. But if we could choose who the most appropriate candidates are for this procedure, we would choose somebody who doesn't have a lot of medical problems, who is otherwise healthy, who can undergo an operation safely without a complication. A person who's tried medications -- because I think I would rather take a pill than undergo a surgery -- but medications don't work or the patient cannot take medications. Patients who have symptoms. If patients aren't bothered at all, well, I think that's fine. But if they're having problems like shortness of breath or dizziness or a racing heartbeat or they're unable to take blood thinners or coumadin or have had a stroke before on coumadin, I think those are all patients that would be ideal candidates for this kind of a procedure.
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PATRICK McCARTHY, MD: Okay. Do you want to talk about who would not be candidates?
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RICHARD LEE, MD: Sure. You know, there's some patients that probably are not the best candidates for this operation. I'd say patients who had had heart surgery before or lung surgery before really are not ideal. After surgery, you get scarring on top of the heart, and a lot of times you saw the pericardium was nice and smooth and shiny and it wasn't really very stuck. After heart surgery, the area tends to get stuck. Now, we have done these before in previous heart surgery, but we feel like the risk for injury is too high, so we really avoid patients who have had prior heart surgeries. Other patients with medical problems who have advanced disease or bad kidney disease might not be good candidates. And certainly it is age-dependent. Although there is no strict age cutoff or heart failure cutoff, the older you are and the sicker you are, the more likely it is to have a problem with this operation, and you need to balance that risk-benefit for yourself. But also, we would steer you away from that operation if we thought you wouldn't have a good outcome.
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PATRICK McCARTHY, MD: Very good. There's several questions about the results, of course. And before we discuss that, we should say that Dr. Lee and his colleagues will be presenting these results at the American Association for Thoracic Surgeons, which is our big major meeting. And they won't really allow you to give all the result out beforehand, but in general terms, Rick, do you want to discuss the results that you've seen with us?
00:52:00
RICHARD LEE, MD: So far, the results have been very good. You know, right now collectively we submitted the first 100 patients all together. Again, that would be Dr. Byer and Dr. Lamb and myself looked at our first 100 patients. But, now, each of us has done even more patients. So when we have a-fib or atrial fibrillation that comes and goes, paroxysmal atrial fibrillation, we think the success is probably around 90-plus percent at beyond six months or longer. And that includes patients who have had -- about between

20% and 30% of those patients had previous catheter ablations. Now, in patients that had a-fib longstanding, I think the results have not been as good. Our earlier results suggested about 70%, 7 out of 10 patients. But I've talked to my colleagues, and we all think that's going to drop off significantly more. So we think that'll probably be more like 1 in 2 patients, about 50%. And that's why we developed this hybrid procedure to give patients a solution, a better solution that they have any other way without undergoing the full maze.
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PATRICK McCARTHY, MD: Rick, do you want to speak to the complications of the procedures, what patients might face with this?
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RICHARD LEE, MD: Now, I think the biggest problem is postoperative pain and spending time in the hospital. Again, most of the patients only are in the hospital four or five days, and the pain gets better readily and we have a lot of things that we do, a lot of ways to control and make that pain bearable. But in the first 100 patients or so, we had a couple patients that did have some bleeding. One patient had to go on the heart-lung machine. He did fine, but he had to go on the heart-lung machine. You can always have an infection with pain. And early on we saw a couple of injuries to that phrenic nerve that I pointed out. Now that we know -- since we've identified that as a potential problem, we really haven't seen it since. But those were the main problems, but the most common problem is just facing surgery and having some pain afterward.
00:53:59
PATRICK McCARTHY, MD: Okay. Other comments: can you perform this in a patient with a congenital cardiovascular defect?
00:54:05
RICHARD LEE, MD: Well, it depends. If a patient had a previous cardiac surgery, I would again say that perhaps a more open or on-pump surgery for atrial fibrillation would be more appropriate. For example, our own -- as you know, our colleagues at Children's Hospital have done a lot of arrhythmia surgery and congenital problems. But I would not do it if they had prior surgery. However, the most common defect, congenital defect, is an ASD, atrial septal defect. And probably the most common way to treat that atrial septal defect is with a catheter. So the cardiologists pass a catheter in and put a little device that closes that hole in the heart. So an atrial septal defect is a hole between the right and left side of the heart. Unfortunately -- which is great and a big advance. Unfortunately, when you have that big metal device there, the way we do the second stage of the hybrid procedure and the catheter approach is to go across that septum with a little puncture from the inside. With that device, you cannot perform a puncture through the device. And I've actually even written a paper on one of our patients who had a device that would perform this stage one successfully.
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PATRICK McCARTHY, MD: And a question from a physician, if you undergo the surgery, can patients undergo later open-heart surgery?
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RICHARD LEE, MD: Absolutely. One of the reasons and one of the advantages we felt for the procedure was you could very safely undergo cardiac surgery in the future. As many of you know, if you have -- as I described, if you have a manipulation, you can get scar. In particular, if you undergo cardiac surgery, and most of cardiac surgery is done with the sternum being open, that's where all the scar is and the heart kind of gets stuck there. With this approach, we don't do anything here, so this is nice and free and it's very safe to undergo cardiac surgery after this approach.
00:56:05
PATRICK McCARTHY, MD: So to summarize, because there's quite a few questions coming in about patients, we wouldn't look at this as sort of the first-line therapy. If you're 50 years old and you just had atrial fib last weekend, you'll start with medications and a variety of

other things. What we should stress, too, and that is coming out here, is that patients should be evaluative for other heart problems and also thyroid problems like hyperthyroidism. But they should have an echocardiogram, because you and I both know that we see patients that are referred to us for the maze procedure, but then when they go through more of an evaluation, it turns out they have a leaky heart valve or they've had a heart attack and they also need bypass surgery. And so they don't end up with this procedure, but they end up having their valve repaired or a bypass. And then also at that same time we treat the atrial fib in about 95% of the patients that are here. So I think that needs to be stressed. And the other is that we also see -- I recently saw a patient that came up from Texas, and she is more 80-ish, and she did have a lot of problems with atrial fib. She also did have a lot of other medical problems. And so it's not for everybody. We always have to make that judgment about what's the risk of doing the procedure versus the benefits. And clearly, those 50-year-old, 60-year-old patients that have had atrial fib for quite a while, very symptomatic, their doctor has been telling them there's nothing that can be done, that's more the kind of patients that will get a good long-term benefit as opposed to some other patients.

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RICHARD LEE, MD: I'd like to build on what you said, especially the first part. You know, I think you're right. You know, we tend to see things through our own eyes: surgeons tend to see things the surgical approach; electrophysiologists tend to see things through a catheter. The way the maze was developed is they had a cardiologist, a PhD physiologist, and a cardiac surgeon working together to see things a little differently. That's what we're offering now. I think, as you said, a lot of patients have problems of an atrial fibrillation that requires a team of specialists. That's why we developed the atrial fibrillation clinic. We have two or three different perspectives for the same problem, and we try to offer the patient with the best solution for him or her.

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PATRICK McCARTHY, MD: So we're getting towards the end here, and Rick, to wrap up, this variation on a -- we've evolved a long way from the maze procedure that we spoke about at the very beginning. But we know that it has a great track record, decreased strokes. There was the earlier use of this newer procedure that's only about four years old, doing this minimally invasive maze. And then the specific thing that you're adding to it with the electrophysiology colleagues is this hybrid approach.

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RICHARD LEE, MD: I think that sums it up very well.

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PATRICK McCARTHY, MD: Other things that we should be adding in here? There's questions about the preparation for surgery. Again, just to evaluate their heart conditions and their overall medical condition to make sure there's not another major problem that they would have. The most frequent that we see, I would say, would be valve problems. And again, the heart.nmh.org tells people a lot about the association of atrial fibrillation with heart valve disease. And that would probably be very helpful for people.

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RICHARD LEE, MD: I think we're running out of time, and what I'd like to do is first thank Dr. McCarthy for joining us, and I'd like to thank all you viewers and everyone that offered questions. I'm sorry that we couldn't get to all of them, but I would encourage you to go to our website and we can answer them at a later time. In addition, I'd just like to summarize by saying, you know, a-fib is an individual problem, and it's a problem that patients have that I think we have a lot of good solutions, but education is the first step. So I would encourage you all to explore it even more and then see a specialist who might be able to help you. Thanks.

01:00:02

PATRICK McCARTHY, MD: Thank you.

01:00:09
ANNOUNCER: This has been an interactive discussion on the hybrid maze procedure, live from Northwestern Memorial Hospital in Chicago, Illinois. OR-Live makes it easy for you to learn more. Just click on the Request Information button on your webcast screen and open the door to informed medical care.
01:00:34
[end of webcast]