# Minimally Invasive Aortic Valve Replacement

FirstHealth Moore Regional Hospital
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Welcome to this ORlive Webcast presentation, live from the Heart Institute at First Health Moore Regional Hospital in Pinehurst, North Carolina. During the program, it's easy for you to learn about the procedure. Just click on the buttons on your screen and open the door to informed medical care.

Good afternoon and welcome to the Heart Institute of First Health of the Carolinas, Moore Regional Hospital in beautiful Pinehurst, North Carolina. My name is John Streitman and I'm a cardiothoracic surgeon here at the Heart Institute. Today we're going to be showing you a minimally invasive aortic valve replacement for aortic stenosis. Joining me today to talk about this innovative procedure is Dr. Jim Winkley, who's a cardiac anesthesiologist that works here with us. Before we begin, viewers need to know that neither Dr. Winkley nor myself have any financial or professional relationships with the manufacturers or the devices used in this continuing medical educational activity.

Thanks, John, we want to remind the viewers if they have any questions during the Web cast you can email them to us by clicking the button on your computer screen, the "Ask a question" button. We'll be answering those questions throughout the program. We also want to remind viewers that the CME credit is available and there will be a test and evaluation at the end of the program to receive this credit. At the end of this program, we will e-mail you the CME certificate after you've completed the post-test and evaluation form. And with that, John, why don't we discuss aortic stenosis?

Thanks, Jim. So aortic stenosis is the primary reason that we end up offering patients aortic valve surgery in our community. Aortic stenosis is a process by which the aortic valve, which is the main valve that separates the left ventricle, or main pumping chamber of the heart, from the aorta, the main artery that leaves the heart. There's a picture on the left of a normal-appearing aortic valve. You can see that valve is made of three pieces of thin tissue that opens freely when the heart contracts. On the right, we see a picture of the aortic valve from a patient who had a very diseased aortic valve. And there's a lot of calcium and thickening of that tissue and does not open easily or appropriately.

This process starts out as a disease we call aortic sclerosis, which is the beginning of the process of thickening and tissue destruction of the aortic valve, and proceeds to aortic stenosis. It's really not felt to be due to wear and tear or normal degradation of the aortic valve. It's more likely a chronic disease process of inflammation and protein deposition that ultimately results in calcification of the valve. It's a disease we see more commonly in older patients in the sixth and seventh decades of life. Again, some areas of the valve appear normal and other areas are thickened and calcified. The problem that aortic stenosis presents is one of increased workload on the heart by causing obstruction of blood leaving the heart easily. This can lead to some clinical symptoms, which we'll talk about in a bit. We see this disease process can be associated with other cardiovascular diseases including heart attack and increased risk of cardiovascular death.

John, is there anything you can do to help prevent aortic stenosis?

There's no prophylactic methods that anybody can take to prevent aortic stenosis from occurring. Interestingly, we do see aortic stenosis in patients younger, in their 40s and 50s, if they have congenitally bicuspid, or two-leaflet valve. With regards to most patients who have a normal three-leaflet valve, it's just

sort of a normal aging process that we see in a certain segment of the population. No medications as such have been proven to slow that disease path life. Again, it's a progressive disease from sclerosis, or the beginning of thickening of the valve, to aortic stenosis. And as an underscore, we want to make sure that patients who have been diagnosed with aortic stenosis or early aortic stenosis know that there is a need to be followed regularly with examinations, et cetera. Again, there's a latent period with regards to progression and aortic sclerosis is not a reason to need an operation or aggressive management at that time. But when it progresses to stenosis, by either an increase in velocity of blood through the valve or a narrowing of the valve area, then symptoms and ultimately surgery may be in the future.

The symptoms seen primarily with aortic stenosis at its end stage and the more severe forms are that of angina, which is chest pain; syncope, described as shortness of breath; or heart failure, which can manifest as easy fatigueability, ankle swelling and a decreased energy level. Some more subtle symptoms can include decreased exercise tolerance; palpitations, or fluttering of the heart; shortness of breath and even light-headed symptoms.

After the onset of symptoms in patients who have severe aortic stenosis, there's a pretty rapid progression into death if no intervention is taken. We feel that there's approximately a 50 percent chance of death two to three years after the onset of symptoms in patients with severe aortic stenosis, thus the corrective surgery of aortic valve replacement.

If I have aortic stenosis, are there any activities that I should avoid doing?

That's a great question, Jim. Generally in patients who have severe aortic stenosis, again just be virtue of the valve itself has narrowed, that puts more work on the heart when a patient's at rest. Increasing your workload in a normal patient, exercise and increased activity increases your heart rate and blood pressure, which then puts more workload on the heart. We would probably not want you to do that if you had severe aortic stenosis, as that could be life-threatening.

So again, in the absence of severe co-morbid conditions or other significant medical problems, the American College of Cardiology recommends aortic valve replacement for basically all patients who have symptomatic aortic stenosis of a severe nature. It's even been liberalized in some patient populations of patients who do not have symptoms but have aortic stenosis should be considered for surgery. Age, in and of itself, is not a reason to consider or not consider somebody for this operation. Again, there's no medical therapy that has been proven to slow or reverse the process of aortic stenosis. Clearly, medical adjustments can be made in patients who have aortic stenosis to minimize their symptoms, but that doesn't impact the course of the disease itself.

When I'm sent a patient with a heat murmur of any variety, this is one of the algorithms we employ. After we do a detailed history and physical examination, we generally recommend in most patients, certainly patients how have symptoms of heart failure or problems related to their heart, we recommend an echocardiogram, or an ultrasound of their heart. Jim, can you expand a little bit for us on what echocardiography is?

Echocardiography is the use of ultrasound technology. Ultrasound technology is a form of the same kind of sonar that they invented back in World War II to look for things in the water. Basically, you use sound waves to bounce off the tissues in the body. Those sound waves bounce back to a transducer, and the computer puts together those sound waves in a two-dimensional picture and allows us to see structures inside the body. We use this in cardiac anesthesiology in the form of transesophageal echocardiography where we place an ultrasound transducer through the patient's mouth into their esophagus after they're asleep. And the ultrasound probe sits behind the heart and gives us excellent images of the heart structure and function and the motion. We're able to look at the aortic valve very well. In fact, transesophageal echocardiography is the best modality to look at the aortic valve because the probe is sitting right behind the aortic valve. Lots of patients on a outpatient basis have transthoracic echocardiography where a probe was placed on the chest wall and moved around and looked at the various structures of the heart. The aortic valve, because of its nature being in back of the heart, is not as

easily imaged. So again, transesophageal echocardiography gives us very, very good looks. It's a great tool to help cardiac surgeons.

Thanks, Jim. And I would underscore again the purpose of echocardiograms, even in the outpatient setting, is to not only define the primary lesion, or problem, that may be causing a patient's heart murmur, but also to evaluate the patient's cardiac function, look for other occult problems with the heart. And it also establishes a point of reference for us to follow patients in the future with regards to progression of disease.

Cardiocatheterization, or heart cath as patients will describe it, is another tool that cardiologists will use to help evaluate both cardiac function as well as anatomy in patients who need heart surgery. It allows us, from an valvular perspective, to know the human dynamic or blood pressure effects of a valvular problem and is also important with regards to determining coronary artery anatomy, as some patients may need coronary bypass surgery in addition to valve surgery. Exercise testing, as I mentioned previously, is a nice way for us to define patients who have more subtle symptoms of aortic stenosis from the perspective of a patient who may be on the surface initially asymptomatic, when they walk or exercise at a mild level may quickly develop symptoms. Those patients should probably be referred for evaluation for surgery as well. I want to underscore again that exercise testing is really not recommended in patient with classic symptoms in severe aortic stenosis, as it's probably more stress than the patient's heart should have to undergo.

Once again, serial evaluations, as with any chronic disease process, are important. In valvular disease, it's primarily being followed closely by your cardiologist with probably annual, if not more frequent, echocardiogram or ultrasound of the heart to evaluate the disease progression.

John, I'd like to interrupt for a minute. We have a question from Andrew who asks, because of the left ventricle's pressure on the aortic valve, is this type of stenosis more common than mitral or tricuspid stenosis?

Aortic stenosis in this country is more common than mitral or tricuspid stenosis, not necessarily because of the pressure in the cardiac chambers, but more having to do with the patient population we treat. In underdeveloped countries, mitral stenosis and aortic stenosis and even tricuspid stenosis from rheumatic causes are much more common. To expand upon that a little bit, patient who have had strep throat that's untreated, which is much less commonly the situation in this country, can have a rare problem where the patient's own immune system will attack cardiac valve structures, causing them to be stenotic or stiffened. So in this county more likely we see aortic stenosis.

Again, patient education is part of the evaluation and management of valvular disease prior to surgery is paramount. It's important for a patient to understand really with any chronic condition what the symptoms or the progression to what symptoms they can expect so that they can report those to their physician. This may lead to earlier treatment and better outcomes as well. Aortic stenosis, as I mentioned, in this country is primarily a disease of the aging population. And, of course, we are a country that is growing in that segment of the population significantly. As such, we now see on the order of 100,000 aortic valve replacements per year in this country and that number is only going to increase with time.

This highlights the mortality or the risk of death associated with aortic valve replacement and other significant operations in octogenarians. This is really, they are two-fold for us to explain to you that, first, there are more significant operations for a patient to have than an aortic valve replacement even in their 80s and also to underscore, again, that even in octogenarians this is a relatively safe operation.

Techniques like we're going to present today that are less invasive and quicker are always better for the patient in the sense of reducing mortality. And we see this over time, if you look at our thoracic surgical database. In this country over time the risk from aortic valve replacement has improved and also on the right hand side of that slide, that demonstrates that patients with New York Heart Association class heart failure 1 and 2 have a lower operative mortality, or risk of death, than those who have more severe heart

failure, again underscoring the importance of patients being referred earlier as this becomes a severe problem for them.

John, I know we're talking about aortic valve replacement surgery today but are there any catheter-base techniques that can be used to treat the aortic valve stenosis?

That's a great question, Jim. Those are coming. There are several valve companies in this country and in Europe that have designed catheter-based valves that are being implanted in this country in the form of trials and in Europe, actually in more liberal form, for more general use. Initially, those are going to be prescribed for patients who would not tolerate well a traditional open operation or a less invasive operation, as we're going to discuss today. But ultimately, like any less invasive technique, that may well have more general application.

I want to talk a little bit about valve prosthetic options. Again, there's two basic valve types that we use in our practice, those being tissue valves and mechanical valves. Tissue valves, if I can demonstrate here, are made out of either tissues from cows or pigs, what we call porcine for pigs and bovine for cows. Essentially, the tissue from these is harvested from those animals and sewn into a man-made strut device that we can then sew into the heart. This demonstrates the appearance of this valve from the ventricular surface as blood exits through the valve. And these valves are an excellent option. They have great properties, from a hemodynamic perspective. Their main limitation is that of durability in the sense that they, on average, 15 to 20 years is what we can expect. This is an example of a mechanical heart valve which is made out of pyrolitic carbon, basically metal and plastic. Again, blood flows through this valve. As the heart contracts and as the heart relaxes, the valve passively closes. These valves are probably more durable in most patients in the sense that they last longer. The downside is that they require a high dose of blood thinner, or cumadin, anticoagulation to be taken for life. So the tradeoff again is tissue valves not quite as long-lasting but just need a baby aspirin and mechanical valves more durable but need high dose blood thinners.

So again, aortic valve replacement, as has recently been underscored in the press, is traditionally performed via full sternotomy or full incision of the breast bone. What we want to present today is a newer technique which allows for a smaller incision of approximately two to three inches in the upper part of the breast bone. We feel that this provides a patient less post-operative pain, blood loss, lung dysfunction. Certainly we can get these patients up and moving more quickly. And we think it's beneficial for patients who are younger and healthier as well as older patients who may have less physical reserve.

So Barbara Bush recently had a traditional aortic valve replacement surgery. What makes a patient a candidate for this minimally invasive type of surgery?

Well, at least in my practice, if I have a patient who is referred for an isolated aortic valve replacement, I think most patients are candidates for that. And, in fact, in my practice I have employed this technique even for patients who have had previous cardiac surgery who need a re-do heart surgery for an aortic valve replacement. So now if a patient needs multiple valves repaired or replaced, or needs bypass surgery in addition to an aortic valve replacement, then this is really not an appropriate technique in my opinion.

So I think, with that, we can evaluate this patient whose surgery we're going to see today, their echocardiogram, or ultrasound, that was performed during the operation.

What we're seeing now is a transesophageal echocardiogram of this patient. Up in the upper left hand corner is a picture of the cross section of the patient's aortic valve, now in full screen. And we see a lot of turbulent flow, as represented by the red and the blue color. Typically, blood flowing through a valve should be nice and smooth. We shouldn't see very much color such as we're seeing here. To the flow to the right in blue is very turbulent flow, which is the stenosis. The blood's having to be squeezed through the valve. And in a second we'll see it again. And regurgitant flow, or flow going backwards through this valve, which isn't supposed to happen, is bright blue and red. And so this valve has two problems. It's not only stenotic but it also has a regurgitant lesion. Just to orient you a little bit, the big black chamber above

all the flashing lights is the left atrium, which receives the blood, which then goes in the left ventricle. The blood then is ejected through the aortic valve and we see in this view right here in the upper left hand corner the blood being ejected. And this is something we use to help guide the surgeons in the surgery.

All right, thank you, Jim. This is obviously just a model of the heart just to give some perspective before we start the first part of the video. Again, when a patient has a full sternotomy, most of these structures we're seeing here can be seen relatively easily. The aorta is this main tube here, which gives off the branches that go to the arms and brain initially. And it exists the left ventricle, which is the main pumping chamber right here where my finger is, through the aortic valve. In this operation, since we don't do a full check incision, we really just need to see this part of the structure, mainly the aorta. So just to orient you a little bit, for the most part what we'll be seeing is this upper part of the aorta and great vessels, not so much of the cardiac structures.

So with that, we can go to the first portion of the surgical video. At this point during the operation, we're just beginning, using some anatomical landmarks to define what size incision we need for any given patient. Again, generally the length of the decision is somewhere between two to three inches, depending on the patient's body, et cetera. We start out, again, with that small skin incision and then we use a cautery device to divide the tissues, the subcutaneous fat and connective issues above the sternum, or the breast bone.

John, while we watch this, you opening the chest here, we received another question from Ginger. She asks, and she says, "I've had an MI, myocardial infarction, heart failure, and that is when it was found that my tricuspid valve only has two flaps instead of one. At this point, should my physician and I discuss a replacement?" And I know we're talking about aortic valves but she was commenting on the tricuspid valve. Can you comment on that at all?

My guess, by the way that it's written, is that what she's meaning is that it's been found that she has a bicuspid aortic valve likely. If that is the case, which I'll assume she means that she has a bicuspid aortic valve, not everyone -- not -- just having a bicuspid aortic valve is not a reason to have surgery. Now having said that, patients who have bicuspid aortic valves are more likely to, than patients with normal tricuspid aortic valves, are more likely to require surgery. And there's also an associating with ascending aortic aneurysms in patients with bicuspid aortic valves. So I guess the short answer would be if by echocardiogram, by ultrasound, there's no significant stenosis or leakage or regurgitation of that valve, then surgery at this point would not probably be required.

So again, you see we've used the cautery to achieve access to the sternum. On the left hand side of the screen would be the patient's head and on the right hand side would be the feet. We're just using the cautery to divide the issues down to the sternum, or the breast bone, at this point. Being as how we level the lower 2/3 of the breast bone intact, what we're doing at this point is dividing the tissues on either side of the sternum so that we actually make an inverted "T" shaped incision in the bone using the sternal saw, which we'll see here in a second.

Is this opening of the chest right now called a mini-thorocotomy or is this something different?

This is a partial upper sternotomy is the name of this incision. A thorocotomy is an incision we generally use for lung operations and for some valve operations in which we actually make an incision on the left or right side between the ribs. So it runs horizontally on a patient, as opposed to this incision being a vertically placed incision in the middle of the upper part of the sternum.

Again, we feel that even though there's a little bit of difficulty in seeing all the structures initially to make these incisions, we feel that patients do benefit from having the bottom half of their sternum still intact. The benefits, in addition to being less pain, are also stability of the breast bone, of the sternum. Especially in younger patients who want to return to work and activity more quickly, we feel that this offers them an opportunity to do that more safely than someone who's had a full sternotomy.

This kind of incision, is it better for the patient for an infectious complication scenario or is it just cosmetic?

No I think the benefits are much more than that of cosmesis. Let me just preface that by saying that my goal, anytime I do a cardiac operation, is to make sure that the operation is executed appropriately and cosmesis is really a secondary or tertiary concern, quite frankly. I think that certainly, again because the sternum, the lower half of the sternum is stable and never divided, that provides more stability to the incision and less risk of infection.

At this point we've divided the sternum and placed a minimally invasive retractor that helps to spread the upper part of the sternum apart. You can see that my assistant and I are opening the pericardium, or the sack around the heart, in which you see this fluid emanating. That's a normal appearance. This pericardial fluid, as we call it, most patients have a small amount. As we continue to use the cautery machine, we will divide this pericardium and then use a series of sutures to retract the pericardium up into the wound, which allows us to get more ready access to the aorta and the aortic valve. The structure you see beating that has sort of those spider-like vessels on it beneath the pericardium is the aorta. And we're just now starting to see a glimpse of the patient's right ventricle, which is the yellowish part with a little bit of fat there on it. You also see bits and pieces of a purplish chamber, which is the right atrium. You'll see it right there underneath the needle. So again, we're just putting these sutures in as a retracting technique.

John, Kay has sent us a question and she has asked -- she says she's been told by her cardiologist that she has a thickening of the septum, along with aortic stenosis. Is she a candidate for the minimally invasive procedure?

That's a great question. So as part of the disease process in any patient or in most patients who come to requiring surgery for aortic stenosis, left ventricular hypertrophy is a common manifestation. By that, I mean generally speaking any muscle that works harder in the body gets thicker and bigger over time and that's usually a problem with patients who have aortic stenosis. In her situation though, it is possible for patients to have an asymmetric hypertrophy of the left ventricle, which is really a little bit different problem that can also require surgery. That's easily approached through this approach, through this incision, as if you need your aortic valve replaced, when we cut the aortic valve out it's very easy to gain access to the ventricular septum if she needs a myectomy, or an excision of some of that hypertrophied muscle.

John, when you're doing this surgery, how do you know what size valve to put in there?

Well, there's obviously different sizes for different patients. There's been a lot of work done by academic cardiac surgeons and cardiologists to try to define an appropriate sized valve based on a patient's size, which we look at the body's surface area. We, in the operating room, have a set of sizers which allow us to determine what the largest size valve is that we can get in any one patient. And we look at a series of charts that we have, historical data, to know really what the best size is for any given patient.

I think we can probably proceed now with continuing with the footage of this domed operation. Now that, again, once we've opened up and we've exposed the aorta, we're putting a series of sutures in the distal part, or the last part, of the ascending aorta. Again, the patient's head is to the upper left of the screen, just to orient you again. These sutures, what we call canulation sutures, we use to secure tubes, or canulas, into the patient's body. In this situation, again this is the aorta, we'll be putting in an aortic canula in. These tubes that we put in the body allow us to connect a patient to the heart-lung machine. And I'd like to, again, expound a little bit on that. This process of putting somebody on a heart-lung machine, we term putting a patient on bypass, which is different than having coronary bypass surgery or any other bypass operation. So placing a patient on cardiopulmonary bypass, or the heart-lung machine as we call it, is really the act of providing circulation so that we can then stop their heart to do cardiac surgery on.

Are there side-effects from being a cardiopulmonary bypass?

There are some side-effects. Obviously, we have to thin out a patient's blood significantly. As you see on the video a this point we're putting a canula now up through the femoral vein, the vein in a patient's groin,

up into the heart which, with echocardiographic guidance now, we're seeing being placed in the right atrium.

We see the wire in the right atrium there and Dr. Streitman will then pass a canula over that wire up into the heart. And we use the transesophageal echocardiogram to make sure the canula, you know, isn't too far in or isn't -- not far enough into the heart. And that will help aid draining of the heart during the cardiac bypass procedure.

Getting back to your question, Jim, on effects of being put on the heart-lung machine, clearly there are effects. There are some subtle neurocognitive effects, some memory loss problems, things like that that are usually transient. They can be found really if you do very intricate neuropsychologic testing on patients who have had heart surgery requiring cardiopulmonary bypass. Again, we have to thin out a patient's blood significantly so there is some risk of bleeding after surgery. And, of course, we reverse and stop those medications once they're not needed any further.

Again, this is now the process of us securing that canula into the aorta. And we have to put another couple of tubes in this patient's heart to continue with the operation. One these, which we'll be placing in a second, is called a ventricular vent. This is a tube in the left ventricle that we place through one of the veins that returns blood from the lungs so that we can have a clear operative field for visualization. And we also have to place a tube in the aorta here in a second, which will allow us to administer a medication called cardioplegia, which is in this patient's situation, basically this patient's own blood with a high amount of potassium that we're going to infuse into the heart to stop and preserve the heart. It also allows us to cool the heart muscle so for that period of time the patient's heart is stopped that as little heart damage as possible occurs.

Getting back to the bypass machine, how long is a patient on bypass?

For this operation, obviously it depends on the specific operation. An operation like this, generally for the entire procedure, and by that I mean after the patient's been anesthetized and we're ready to start the skin incision, the entire time of the operation is about three hours, plus/minus. In this patient's situation, I think it was a little less than two hours. Not all of that time is spent on the heart-lung machine. Once we canulate, as we're still doing at this point, and putting the tubes in the heart, and we've completed that, that's when we start the heart-lung machine. And then we stop the heat, cut out the aortic valve, replace it, close up the aorta, restart the heart and then after the patient's heart has recovered, come and take them back off the heart-lung machine. Again, generally speaking, the amount of time the heart is stopped is an hour or probably a little less in most cases. The amount of time on the heart-lung machine may be an hour and 15, an hour and 20 minutes. Obviously that's longer if a patient needs bypass surgery in addition to that or their valve's operated on. So again, at this point we've completed putting all the tubes in and we're really ready to place this patient on the heart-lung machine so we can proceed with the operation.

One of the questions I just received asked about the valve. Perhaps you can comment on that in a minute, but Gordon asked why the body doesn't reject these valves that we put in, specifically tissue valves.

That's a great question. Obviously in patients who have organ -- receive organ transplants, whether it be heart, lung et cetera, the immune system recognizes those living issues as not being from the patient who receives them and the body tries to reject or get rid of that issue. These are inert valvular prosthetics, both the tissue and mechanical prostheses are. Not to say that some destruction over time doesn't occur with both tissue and mechanical valves, as I mentioned previously. Tissue valves do not last indefinitely but there's not a rejection process, as such, that requires immunosuppressant drugs or other medications to be taken.

Those are great questions. I want to encourage everybody that has questions to click the "Ask a question" button on your Web cast to keep sending those questions in.

So at this point, we'll proceed with the next portion of the footage of the aortic valve replacement. Again, at this juncture of the operation, we would have started what we call cardiopulmonary bypass and be prepared to place the aortic cross-clamp on, which is the clamp that now separates the patient's body from the heart and lung circulation, so that we can open the aorta safely and replace this patient's aortic valve.

You can see now, well these are actually some sizers, as you mentioned previously, Jim, you asked about how we know what size a patient's aortic valve or what size a patient can accept from an aortic valve standpoint. Those sizers help for us to figure that out. You can see at the bottom portion of the screen, that shiny silver clamp, that clamp is now in place to separate the patient's heart from the rest of the circulation. And with those scissors, we meticulously open the aorta so that we can inspect and evaluate the patient's aortic valve, proceeding with the aortic valve replacement.

When we do these operations, this really is open heart surgery as opposed to when a patient has coronary bypass surgery, their heart is really not open. So it's a little bit of a misnomer in the sense that many lay people may think that if they've had bypass surgery that their heart's been opened, and in fact it has not. This is, when we do open heart surgery here, we actually insufflate, or instill carbon dioxide gas into the field, which we think may have some beneficial effect with regards to neurocognitive problems after surgery.

At this portion of the operation, we're excising. This is the aortic valve right coronary cusp that we're excising with scissors. You'll see, as these pieces of tissue are removed, that this is a thickened yellowing tissue, where a patient who has a normal aortic valve would have almost translucent tissue in that same location. Once we excise the valve, it's common for a patient to have a significant amount of calcium in the annulus, which is sort of the circumferential ridge inside the aorta from which this valve arises. Debriding this calcium is of importance in us being able to get the largest size valve in as possible, as well as making sure that the valve seats appropriately and that there's no leakage around the circumference of this valve.

John, just to interrupt for moment, Charles, Charles V., asks can the mitral valve also be replaced using the minimally invasive technique.

It can. It can be repaired or replaced with minimally invasive surgery, not through this incision. There are, from an open surgical perspective, there are lower sternal incisions instead of this begin an upper sternal incision. Again, there's a right thorocotomy and even a left thorocotomy approach to the mitral valve. There are some pioneers in cardiac surgery who have done a significant number of mitral valve repairs utilizing robotic techniques as well, which is really outside the realm of this broadcast.

So at this point, you see we're placing sutures in the annulus of where the patient's aortic valve was before. These are the same sutures that we'll place through the sewing ring of the prosthetic valve to then place in her heart.

Bob asks if there's a reason why your assistant surgeon is wearing brown gloves.

A good question. I don't have a specific answer for that other than there are many surgical glove options and I guess that's his choice.

Tariq asks, can we see one day that minimally invasive techniques to replace conventional heart surgery altogether?

I think that that's generally the thrust of most people how do what we do for a living. As I mentioned, there's catheter-based techniques that are in trials now that may ultimately become the way we do primary valvular surgery. I think as physicians we owe a responsibility to our patients to try to make procedures less invasive, easier to recover from, while at the same time offering equal or better outcomes than the more invasive approaches. So we'd all like to think that we can continue to be progressive and less invasive in how we care for our patients.

Here's one from one of our viewers that must be a techie. He wants to know what make of retractor are you using for the aortic retractor, I believe.

Actually we've used a couple of different ones. That's -- the retractor that we were using on this broadcast is an Ankeny retractor with two blades removed on either side. We actually have now moved to using a Cooley retractor that we've had customized by an instrument company for this approach that really works nicely for all our patients at this point.

I think at this point we can proceed with the video footage of actually placing and seating this valve. Again, this is the same type valve that I demonstrated here today. The silver attachment on the end is the holder which allows my assistant, as you see, to hold the valve so that we can place the sutures through the rings circumferentially. I'm pretty regimented about how many sutures I put in an aortic valve replacement. And I think it is very important to try to make this operation as reproducible as possible. As you see, again, those needles pass through this Dacron sewing ring. Dacron is a woven polyester material that's used for -- it's basically a medical grade fabric. And again, I want to underscore that these tissue valves are hand-made in factories and undergo quite a bit of testing and tolerance before they ever reach our shelf.

Once we've placed all these sutures, the valve then slides down in what we call a parachute technique, as we keep tension on all the sutures into the same position in which the patient's own native aortic valve previously was. We have to be careful when we place this valve that we don't obstruct coronary blood flow. The two main heart arteries, the left and right main coronary arteries, again as you see us sliding this valve down into the aorta, those arteries arise very close to where this aortic valve was. And it's important that we do not obstruct the blood flow to either of those arteries. It would certainly be a catastrophic event.

So as we seat, or slide, this valve into the location, once we get in a location where we feel like it is well-seated, we can remove that valve holder and tie the sutures in. Once the sutures are tied and we feel comfortable that the valve is secured appropriately, then we proceed with the closure of the aorta and restarting the patient's heart.

What is the expected durability of these tissue valves as opposed to a mechanical valve?

There are a lot of factors that go into that in any given patient. On average, I'll counsel patients that, you know, 15 to 20 years is not an unreasonable expectancy for these valves. You know, patients who have other factors, patients who have chronic kidney failure for example, may have a lesser life span because those patients do tend to have calcium deposits in their issues more readily. You know, with any prosthetic valve or any prosthetic in general placed in the body, there is a small lifelong risk of infection. And obviously if a prosthetic valve, whether it be tissue or mechanical, were to become infected, we generally recommend explantation and reimplantation of a sterile valve. Again, I want to underscore that any patient who has a prosthetic valve should let all their treating physicians, dentists, et cetera, know that so that they may be considered for prophylactic antibiotics to prevent such a problem.

Is there a higher risk in someone with a biological valve for endocarditis as opposed to someone with a mechanical valve?

There's not. You know the foreign body, you know, there's foreign material in both of those prosthetics. And so in theory, the risk of prosthetic valvular endocarditis is the same, regardless of the valve option chosen.

So now here we've tied all the sutures and we're cutting out the remaining portion of the sutures and the valve is well-seated. Once we inspect and make sure that there's good clearance for both the coronary arteries and that the valve appears to be nicely seated, then we'll proceed with closure of the aorta at this point.

Earlier this month Robin Williams had his aortic valve replaced and his mitral valve replaced. Is it common to need both of these done at the same time?

I wouldn't say it's as common as needing an isolated aortic valve replacement or an aortic valve replacement with bypass surgery, but it's not exactly uncommon either. Certainly with very long-standing aortic stenosis, mitral valve leakage, or regurgitation, can certainly be a problem.

Would you care to comment on the procedure of taking out a pulmonary valve and using it in the aortic valve? One physician, we've heard of that before.

Yeah, that's what we call a Ross procedure. It's certainly got its place in cardiac surgery and valvular surgery. Traditionally, that's an operation reserved for younger patients who may require more than a 15 or 20 year durability in their procedure and probably most appropriately used in patients who are not of adult size in the sense that basically that procedure takes the pulmonary valve out of its anatomic position, puts it in place of the aortic valve and then requires a cadaveric, or a deceased person's, pulmonic valve to be placed in place of the pulmonary valve. So the benefit is certainly that a patient's pulmonary valve in the aortic position will grow over time and proves a nice replacement. However, that's sort of operating on two valves to fix one valvular problem. And for most patients in our practice in their 50s, 60s, et cetera, we tend to recommend that just an isolated aortic valve replacement.

Not really an option.

So again, about aortic valve replacement, it's traditionally performed via full sternotomy, or incision in the sternum. You know, again what we're shown today is this newer technique. And we'd like to kind of finish up with showing the closure of the aorta, the restarting of the heart and, again, underscoring this less invasive procedure event.

So this is closing the aorta or this main artery, with a ring suture. This is a Proline suture. Proline is a different suture than we've used for the other parts of this operation. It's essentially fishing line type material. It's got an extreme amount of strength, which obviously you would want in a highly pressured blood vessel like the aorta. This is a two-layer closure we use in this operation to ensure that there's no significant bleeding.

Terry asks if you do robotic valve replacement surgeries.

I do not. It's a good question. You know, there's a handful of surgeons, frankly, in the world that I think do enough robotic cardiac surgery, whether it be valve surgery or coronary bypass surgery, to be really proficient at it. There's a significant learning curve and I think that the benefit I'm not sure is there from a clinical perspective. There certainly is benefit to less invasive approaches, but in some of these series, when you critically look at the literature, the operative times can be significantly longer and you know, the longer a patient's on a heart-lung machine or under anesthesia, you know, the more untoward events that can occur. So I think any time, again, you want to embrace less invasive or more progressive technology, you want to make sure that it's not any worse, and hopefully better, for the patient than the, you know, standard procedure. And that's why I think that this is a nice opportunity to offer that. This is not a robotic procedure, but still a very small incision, and I think from a patient's perspective, doesn't increase -- in fact from my experience has shortened -- the duration of the operation. So I think that it's really what we're looking for.

Thank you. What are the benefits of minimally invasive surgical techniques to both you, as a surgeon, and the patient? Zack wants to know that.

I'm not sure there's a benefit to the surgeon in minimally invasive surgical techniques. It's not necessarily somatically painful, but it is painful as a surgeon to work in some of these smaller, more confined spaces. There's clearly less control at times, and so you have to anticipate and be very comfortable with what you do. I do a lot of valve surgery. You know at this hospital we do well over 150 valve operations a year and, you know, probably 30 to 40 minimally invasive aortic valve replacements a year. So one of the things I

would counsel anybody is before they ask for a minimally invasive operation from a surgeon, make sure that surgeon is comfortable doing traditional open valvular surgery and a significant volume of it. And so, from a surgeon's perspective, I'm not sure there's a huge benefit. From a patient's perspective, there's clear benefits, again as we've underscored: pain, blood loss, operative times, recovery. There are a lot of reasons that if I needed a stand-alone aortic valve replacement, I would want a less invasive approach.

So with that, maybe we can proceed with the final portion of the footage, which is now sort of finishing up, closing up and getting out of the operating room. At this point, we're putting some temporary pacemaker wires on the patient's heart, which we do on most patients who we do heart surgery on, and also placing a small drainage tube. Jim, here's some footage of the echocardiogram, or ultrasound, again after the aortic valve replacement which may shed some light.

This is just showing unobstructed flow and the absence of regurgitant flow through the aortic valve in a cross-sectional, longitudinal view. Again, the aorta is -- oops -- was the black tube below that. Just shows that a very good repair or replacement had been done.

Well, and I think we'll see some more footage here in a second that we can expand upon. As you can see now, what the movement of the tubes in the operative field, we've again removed the aortic clamp. We've restarted the heart and we've begun the process now of separating or removing this patient for cardio-pulmonary bypass and taking all these tubes out, or canulas. Again, it's important for me to know, intra-operatively, how a valve repair or replacement is working. And Jim and his colleagues do an excellent job of that for us so that we can make sure that our valve prosthesis is working well or our repair is working well.

Again, this is the process of using the same sutures we placed in the aorta to tie and close the hole as we remove this canula, or tube. Once we've removed these tubes, we give a medication called Protamine, which is a reversal agent that stops the blood from being thinned out, allows the patient's blood to clot normally so that bleeding is not a significant problem.

John, Doug asked where the carbon dioxide was coming from that you motioned earlier on the video.

We have a tank just like any medical grade gas that this off of the operative field and that sterile tubing is passed off and connected to that tank so that we can instill a small amount of carbon dioxide to the field. Again, it's our practice pattern here. Carbon dioxide is heavier than natural room air and oxygen, and so it tends to instill or be instilled into he field. And carbon dioxide more readily bubbles out of the bloodstream and is thought to cause less untoward effects to the brain and other tissues.

So again, as we're finishing tying up these sutures and closing up, you can see the patient's heart appears to be functioning well from our perspective. Again, we use the echo to help that., help evaluate that. This is the placement of the sternal wires. We use some heavy stainless steel wires to reapproximate or put back together the sternal edges. Once those have been placed, as you see here, we place a little antibiotic solution onto, into the wound, make sure the wound itself has pretty insignificant bleeding and then proceed with closing the tissue with several layers of absorbable sutures. Of course, those stainless steel wires in anybody who's had heart surgery generally are never removed and generally don't cause any problems. And all this suture material that we put outside of the sternum is absorbable and the wound heals up really without problems.

John, Doug has also asked if the electrical pacing system is located anywhere near that valve and how do you avoid damaging it.

That's a good question. The conduction system of the heart throughout the heart structure is located closely to many of the valves. And it is possible with aortic valve surgery for that tissue to be damaged by either removal of the previous -- of the patient's aortic valve or placement of a prosthetic valve. That risk goes up as you do more valve surgery in the sense that if you need an aortic mitral and tricuspid valve replacement, the risk for needing a permanent pacemaker is significant. We use these temporary pacemaker wires in everybody, or place them in everybody we do heart surgery on really more as a

parachute in case we need them. But again, in this operation, we rarely see anybody needing a permanent pacemaker and rarely need those pacemaker wires after the first day after surgery.

Okay, we have another question from Fran. She asks if you've noticed an increased incidence of pacemaker, needs of a pacemaker or perivalvular leaks with this minimum invasive techniques.

Well, we haven't. Again, the exposure with regards to the aortic valve and seeing the aortic valve prosthesis, really is not much different than a traditional sternotomy, so I've not seen a significant increase or significant incidence of perivalvular leak in our patients. And again, the pacemaker requirement, we've not had in the last year that I'm aware of a patient need a pacemaker with a minimally invasive aortic valve replacement. So those risks are certainly there but in my experience they're no higher than in someone who's had a full sternotomy.

Is the patient at risk for needing lifelong anticoagulation with this surgery or is it depending on what kind of value you use.

It depends on the valvular prosthetic chosen and other medical problems. So if the patient has chronic atrial fibrillation, for example, and needed to be on cumadin lifelong before surgery, well of course they'll still need that after surgery. If a patient chooses a mechanical valve prosthesis, they'll need lifelong cumadin. But in our practice, patients who have isolated tissue valve replacements who don't have another indication for cumadin go home on aspirin a day, from that perspective.

Good. I think we've got some -- maybe some more detailed echocardiographic footage of this case that you want to expand some upon then Jim.

So this is a very nice short axis view where we're looking right down the aortic valve and that's the new aortic valve that Dr. Streitman's placed. And you see now nice, thin leaflets instead of the thickened ones we saw before. The black chamber above it is the left atrium. And we see very nice valve excursion. It's opening wide open. And again, here we have a long axis view of the aortic valve. And the turbulent flow is gone. The regurgitant flow is gone, just have a very nice, wide open aortic valve. I can also comment in the view here you can see the patient's left main coronary artery, which is the tubular structure coming off the valve at approximately the 2 o'clock position. And that's the left main coronary artery that Dr. Streitman has to avoid when he's placing that valve, making sure it's seated properly and not to obstruct the let main coronary artery, as that would be a serious complication of the surgery. This is going to loop through a couple more times. We have another question. Marie asks if there's a chance of leaking where the aorta has been cut.

There is. Again as I mentioned, when we sew that aorta up, we have to make sure that that's a water-tight closure. When you take the clamp off, it's generally apparent if there's a leaking spot in the aorta and repair stitches can usually take care of that problem. You know, obviously different patients, different ages, different other medical problems, patients can have problems with their tissue integrity. And so, you know, in the very elderly patients who are on steroids and other medications, it's not uncommon to have more problems with their tissue quality and so we do have to be careful of that, again, whether a minimally invasive approach or a traditional open operation.

I'd like to show some pictures. These are some patients who were kind enough to let us take some pictures to demonstrate the scars that they see. This is a patient six weeks out from the operation. Again, same patient, you can see that length of that incision is a little less than three inches or so there, right that three inches, 2-1/2 -- three inches. And patients, again, are very satisfied with the cosmetic appearance. From my perspective, again that's not a primary concern but from a patient perspective, that's the only thing they see out of their operation. And so we are cognizant of that. And, as we're seeing patients back annually, which we feel is our responsibility any time we do valve replacement or repair on them, it's tremendous a year later how much more contraction we see in those scars and how much smaller they look. So patients are certainly satisfied with that aspect of it.

Well, John, we have a few more questions to answer from some of our viewers. Richard asks, he says he's had an open surgery for an abdominal aortic aneurysm. Does this mean it may be a marker for an aortic valve problem in him in the future.

That's a good question. Not necessarily. Now certainly patients who have had aneurismal disease in their aorta in their abdomen are at higher risk than someone who does not have an aortic aneurysm in the first part of their aorta there, their ascending aorta. That's still a relatively low risk. And the present of an aortic aneurysm in the ascending aorta does not mandate the presence of aortic valve disease that needs an operation. But you know, having said that, as we've underscored previously, patients who have aortic stenosis are more likely than patients who don't have other cardiovascular conditions: coronary artery disease, peripheral vascular disease, et cetera. So you know, generally what I would say to a patient like that is if you had symptoms that may sound attributable to cardiac problems -- chest pain, shortness of breath, exertional problems -- then being seen by a cardiologist or your primary doctors and someone listening to make use you don't have a cardiac murmur is certainly reasonable. And if you do, again, an echocardiogram can help shed some light on what's going on.

And I would guess, speaking as an anesthesiologist, if you had an abdominal aortic repair, he would have had a cardiac evaluation prior to that and they probably would have recognized if he had aortic stenosis.

Jim, generally speaking, I would say I would agree with that.

Susan asks why are there not more doctors around the U.S. who do this procedure? I had to go out of town to find a doctor that does this.

That's a good question. You know, as any of us in practice, there's a tendency to stagnate to some degree, I think, and to not be maybe as progressive as we could. There's a zone of comfort, I think, in doing an open operation. And so, and again volume is somewhat of an issue. You know, I would say that a patient or a surgery who wants to try to employ this technique, it's really not for the surgeon who does one or two aortic valve replacements a month. And so, you know, those factors I think all kind of go together. You really want a surgeon who's got a significant volume, who's got a significant interest in staying progressive and maintaining a progressive practice and who's willing to try newer procedures.

Great. Doug asks -- this is another question -- he's got a lot of questions. He says, "Is the electrical pacing system located near the valve?" And we've already commented on what you do to avoid damaging it and what it looks like, can we see it.

You can't really see it. There are other parts of the heart where you can maybe just see some tissue that you would think is the AV node or the connection between the top and bottom chambers electrically. With regards to aortic surgery we, as surgeons, know from our anatomy training during our course of training, we know where to predict that tissue to be. And we try to avoid putting stitches in those areas. But sometimes, again depending on the amount of disease and what needs to be excised, sometimes it's inevitable that that gets damaged. And infections of the aortic valve, for example, sometimes that tissue is damaged as part of the infectious process.

And the last question here from Butch, he asks, "Because the coronary arteries have been removed from the semilunar valves, do the coronary arteries now fill with left ventricular contraction versus aortic backpressure?" I think he's wondering if you've taken off the coronary artery.

No, no, the coronary artery is staying there in their anatomic position. While we excised the valve, they still say where they are. And again, we have to be careful when we place the valve that we don't obstruct the flow through those coronary arteries, but we leave them where they are.

So John, if I'm looking for someone to do minimally invasive cardiac surgery, what attributes do I want to look for in a surgeon or a program?

Well, I think, as with any procedure, never be afraid to ask that person who's doing the procedure, "Have you done it before? How many have you done? What are your outcomes?" I think all of us, as surgeons and proceduralists, owe it to our patients to be forthright with that information and certainly shouldn't be insulted by that. So you want to look for someone who has a significant volume of whatever procedure it is you need to have done and then ask them why they think it's better and, you know, really investigate those kinds of things. The Internet nowadays is a great place, as we're demonstrating today, to learn about procedures. And I think that patients now more than ever have the ability to be educated about those kinds of things.

All right, so I think we're done with regards to questions at this point. We'd like to make several statements to first the patient who was kind enough to let us videotape her surgery and allow us to use this to help educate our audience. Jim, I want to thank you for being with us today. It's been a pleasure. We also want to remind our viewers that if you missed any portion of the broadcast of if you've got friends or family members that you think might be interested in this, that it will be archived on the ORlive Web site and ORlive.com and, of course, a link also from our hospital's Web site, Firsthelp.org, to the Webcast will be available for some time.

And again, we want to remind anyone that applied for the CME credit to complete their post-test and submit that online so that they can appropriately receive the credit. Again, we thank you for being with us this evening and have a good night.

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