

**MITRAL VALVE REPAIR SURGERY
MEMORIAL HEART AND VASCULAR INSTITUTE (MHVI)
LONG BEACH MEMORIAL MEDICAL CENTER
LONG BEACH, CALIFORNIA
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00:00:09

ANNOUNCER: Welcome to Long Beach Memorial Medical Center. Over the next hour, see a mitral valve repair using the da Vinci Surgical System. Mitral valve repair is a treatment for mitral valve prolapse and stenosis. Prolapse is a common heart disorder in which the valve between the heart's left upper chamber and left lower chamber doesn't close properly. This condition, sometimes leads to blood leakage backwards into the left atrium. Mitral valve stenosis is a condition in which the heart's mitral valve is narrowed. This narrowing blocks the valve from opening properly and obstructs blood flow between the left chambers of the heart. In just moments, see how the da Vinci Surgical Robot increases the physician's surgical precision, range of motion, and dexterity. Patients who receive minimally invasive surgical procedures general experience less blood-loss, less scarring, and quicker recovery. OR-Live makes it easy for you to learn more. Just click on the request information button on your webcast screen and open the door to informed medical care. Now let's go to the operating room.

00:01:16

REX WINTERS, MD: Good morning and welcome to Long Beach Memorial Heart and Vascular Institute. I'm Dr. Rex Winters, Director of Invasive Cardiology, and have the privilege today to be in the Cardiac OR with doctors Dan Bethencourt, Director of CT Surgery. Today Dan is going to be performing an endoscopic mitral valve repair with atrial fibrillation ablation procedure. He's in the OR with his team now. But before we get there, a little history on the patient that he's working on: she is a 33 year old female with a history of progressive congestive heart failure class III despite aggressive medical therapy. Echocardiography preoperatively revealed an enlarged left atrium to 60mm and a mildly dilated left ventricle with normal overall ejection fraction. She's had refractory atrial fibrillation and progressive heart failure now for several months and now is undergoing endoscopic mitral valve surgery again with endoscopic atrial fibrillation ablation. So without any further ado, I'm going to turn it over to Dan in the OR. Dan, can you hear me?

00:02:13

DANIEL BETHENCOURT, MD: Yes, I can hear you.

00:02:14

REX WINTERS, MD: Great. Welcome and thanks for having us. If you could just update us on where you'd be in the procedure.

00:02:23

DANIEL BETHENCOURT, MD: Sure.

00:02:24

REX WINTERS, MD: Just so you know Dan, I've given them a little background on the patient and what we're looking at as far as pre-diagnosis and pre-OR diagnostic testing. So I think we're just looking to see where you're at at this point.

00:02:36

DANIEL BETHENCOURT, MD: Right. We are preparing the pericardiotomy in the operative field for us to do the repair procedure. We're not yet on the heart-lung machine - the heart-lung bypass machine - so that the heart is beating and pumping the circulation as it normally is. We are suturing here the covering of the heart - the pericardium - so that we can essentially have a platform behind us from which to work and open the heart just in front of us in the left atrium. Here you go. So these are what we call "stay sutures;" these are sutures that are in the pericardium that are secured outside the patient.

00:03:28

REX WINTERS, MD: Dan, are those new socks that you have on?

00:02:30

DANIEL BETHENCOURT, MD: Pardon?

00:03:31

REX WINTERS, MD: Are those new socks you're wearing down there to work the pedals?

00:03:33

DANIEL BETHENCOURT, MD: Yeah, these are my usual "robot socks."

00:03:38

REX WINTERS, MD: Well, tell us a little bit about what you think the advantages are to this approach versus some of the other approaches that you're accustomed to using.

00:03:45

DANIEL BETHENCOURT, MD: Well, this approach is completely endoscopic. Are only approach to the patient is with small puncture holes within the chest wall. We don't have to stretch anything or pull between the ribs. So there's a lot less pain associated with it. I think I can move now and show you the operative field. Okay, we're going to be read to go on the heart-lung machine?

00:04:15

DANIEL BETHENCOURT, MD: Yeah. Okay.

00:04:16

REX WINTERS, MD: Dan, just as a follow-up, besides just the local trauma, are there any benefits as far as patients getting out of the hospital or decreasing atrial fibrillation rates, morbidity, mortality...that kind of stuff?

00:04:27

DANIEL BETHENCOURT, MD: Yes, mainly the patients have dramatically less pain. And they get out of the hospital much faster - typically two days after surgery. Excuse me one second.

00:05:08

REX WINTERS, MD: So basically what they're checking on now is Dan's working the cardiopulmonary support system that we mentioned earlier that either went into place. Unlike standard cardiopulmonary support where you clamp an aorta and put big cannulas in, this is done all percutaneously through the common femoral artery and the sheath that is used there. And this balloon is then fed up the ascending aorta, and the perfusion and cardioplegia is administered via those catheters. Again, there are some catheters that are placed in the coronary sinus retrograde cardioplegia as well. So it's very important that before anything can be done on the valve and the actual real reason why he's here and what he's going to be performing, that all these support systems are in place. As you saw in the background earlier, for those of you that are familiar with looking at ORs and Cath Labs and hospitals, you saw a big echo machine in the back ground. That's a Transesophageal Echocardiogram that basically is used to monitor the patient not only preoperatively but during the procedure for the placement of the CPS and

cardiopulmonary assist systems. You can actually see the balloon in the aortic arch and make sure you have the placement where you want it before you even start to tell the heart muscle to do the valve surgery. Dan, are you in a place where you can update us?

00:06:40

DANIEL BETHENCOURT, MD: Yeah, we're about to go with the heart-lung machine, but we have to make an adjustment to one of our two tubes that goes into the patient to go on the heart-lung machine. You'll see here in the groin that we have a cannula in the large artery, the femoral artery, and another one in the vein. The vein goes up next to the heart and draws all the blue blood back into the heart-lung machine. And then it gets filled with oxygen and pumped back in through the artery cannula so that the whole circulation of the patient is supported, or is taken over, by the machine during this time. The patient's body, head, everything is getting blood flow from the heart-lung machine. Right now we've got to make an adjustment to one of the two tubes. I need the dilator back because we're not getting the pressure that we want to see here.

00:07:45

REX WINTERS, MD: Well, while Dan's doing that I'll just mention that some of the preoperative diagnosis that was done on this patient like I mentioned was transesophageal echocardiography. The decision really comes down to the surgeon looking at these particular images and deciding what parts of the mitral valve apparatus really need repair to restore normal function. There's no doubt with patients with this kind of clinical history and presented at this state of the disease that the annulus will be dilated. And for those of you that are cardiologists or taking care of patients with these, that's one of the first things that happens and certainly is a very consistent finding in almost all these patients. The next thing that needs to be decided - and not particularly in this case because this is not a myxomatous mitral valve - but in myxomatous mitral valve or mitral valve prolapse patients, oftentimes there is an excess of tissue at that valve leaflets. And what used to be done is these excess tissues used to be cut out and the valve leaf used to be sewn together. Nowadays guys like Dan and various other people that are doing this with all different types of approaches are trying to save as much of that valve tissue as possible. It allows the valves to collapse normally once the procedure is done. And it allows for the pressure to be maintained within the ventricle at normal levels. And the longevity of the mitral valve repair is much better if those leaflet tissues can be salvaged. The third thing that goes into these patients is an elongation of the chordal structures. The chordae tendinae are the structures that basically attach the papillary muscle - which is part of the ventricle - and then insert on the valve leaflet that allow it to open and close. Those particular chordae tendinae most of the time, especially in the posterior mitral valve leaflet, will be elongated in patients who present class III and IV CHF symptoms regardless of the underlying ideology. So you're dealing really with three things that need to be looked at preoperatively, or at least interoperatively before you decide your final approach. And that is (1) what is the status of the annulus, (2) what is the status of the valve leaflets, and (3) do the chordae need to be replaced with what now is being used is synthetic types of tissue and chords. Those are the things that have gone into Dan's decision. I think what he's decided to do here because the valve leaflets seem to be well-preserved, there's no significant chordal elongation especially on the posterior mitral valve leaflets, I think he's planning to do an annuloplasty in a ring. And then due to the large left atrium in refractoriness in fibrillation, he'll proceed ahead and do a maze procedure, an endoscopic ablation procedure to help assure the patient back inside its rhythm. Along the same pathway, there'll be some closure of atrial appendage so that we can

try to limit embolic phenomenon and those kind of things as well. So Dan, are you about set to come back?

00:10:47

DANIEL BETHENCOURT, MD: We just went on the heart-lung machine, and we're now filling this balloon that's going to occlude the aorta above the heart. So this is going to stop the blood-flow to the heart so that we can infuse this other solution that will protect the heart also.

00:11:04

REX WINTERS, MD: So what do you see in there on the screen, Dan?

00:11:06

DANIEL BETHENCOURT, MD: On the video screen, you're just seeing the aorta which is, you'll see in the center of the field, in the center you'll see the aorta itself from the outside. So we're in good shape. What's your balloon pressure?

00:11:39

DANIEL BETHENCOURT, MD: Okay, that's it. Cardioplegia now. We put a balloon catheter inside the aorta. We filled it up with saline to occlude the aorta so now blood flow is going to the heart. Now we're going to infuse a solution of blood and potassium that will slow and then stop the heart. It will also preserve the heart's function throughout the procedure. So we'll be giving the heart repeated doses. Are we still occluded? Repeated doses of this solution with potassium will arrest the heart or stop it so that it's not consuming any oxygen. And that allows us to work with the heart and still preserve every bit of the heart's function for the patient later.

00:12:42

REX WINTERS, MD: Dan, we talked a little while you were getting the patient ready for bypass. We talked a little bit about the preoperative workout including CTs for this particular CPA System. We also talked a little bit about echocardiography, looking for annulus dilatation, chordae lengthening, and just the valve leaflets themselves. So I think we're pretty well set on a background on what things need to be looked at when you start this kind of thing. If you could just update us perhaps when you get a chance on what have you decided to do with this particular patient and why, and perhaps get a look at those peripheral systems that you have already in place.

00:13:21

DANIEL BETHENCOURT, MD: I'm sorry. Can you repeat that, Rex? We're just adjusting the cardioplegia here.

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REX WINTERS, MD: Yeah, if you just give me an idea, or give us an idea of what you've chosen to perform - what procedure on the patient based on what you saw by TEE and other things.

00:13:37

DANIEL BETHENCOURT, MD: Yes. The TEE tells us exactly what the valve anatomy is - what the problems are with the valve. And so that will allow us to design the operation for the patient before we start. And the typical things are the stretching of the valve which is the whole problem with this patient. The chords themselves can be stretched or broken, in which case we do a replacement of chords. Or the portions of the leaflet can be stretched out as well, and we do some form of localized reconstruction for that. And so today what we have is just a dilatation or stretching of the valve and the reshaping. The valve goes from an oval shape which it's supposed to be to a round shape. And we'll be restoring that oval shape with a ring device as you'll see. Why did the pressure just drop.

00:14:38

DANIEL BETHENCOURT, MD: Can you raise the systemic pressure up?

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MALE VOICE: [Unintelligible]

00:14:42

DANIEL BETHENCOURT, MD: To about 60, 65. Balloon position is stayed okay?

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FEMALE VOICE: [Unintelligible]

00:14:48

REX WINTERS, MD: So as you can see from the comments that we made earlier as well as the comments from Dr. Bethencourt here, it's really important to try to preserve the valve function regardless of your approach to maintain a normally-functioning valve. It's very important that the annulus be matched to the patient's size and returned to normal - not just as Dan mentioned the size but also the configuration from oval to round and when the patient gets dilated from round to oval when you've actually made the repair. It's also very important that the leaflets - we used to believe that the leaflets could, as long as they coapted and came together, that was fine as long as by TEE there wasn't a major leak. We now know that the leaflet morphology really naturally is not with the tips connecting but with the valve leaflets coming together. So it's going to be very important that when you do mitral valve repair that you have leaflets that are able to function. You don't have one set in stone on one side. Otherwise acutely or certainly over time, that valve repair will not be as confident as it would be if the valve, the chordal structure and the annulus all returned to normal size. Unfortunately, with the aggressive use of transesophageal echocardiography before during and after the procedure as well as the instruments that allow you to maintain position without making larger incisions, endoscopic procedures like this pretty much assure across the board that the right patients, if they are selected, will end up with a normal functioning valve and ventricle. Danny, how we doing?

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DANIEL BETHENCOURT, MD Hold on a second, Rex. You'll have to come back to us. We have a number of things to take care of at once here. Is the balloon out of the valve now?

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REX WINTERS, MD: The important part in all these procedures is not much different than what we do in the coronary cath lab and other parts of medicine - is to try to do as much as we can minimally invasive. The difference between a sternotomy and a partial sternotomy is not as significant as the difference between a sternotomy and an endoscopic procedure. And even a port access procedure has a fair amount of trauma with breaking and stretching a bridge and cartilage repair. Patients end up having a fair amount of discomfort long-term with that. So to be able to go truly endoscopic is a plus. The downside to endoscopic is the systems that we need to support the patient. And although they have been much, much more advanced with some of these systems that you see in place right now, there are still some limitations compared to the older versions of how we do these things. For example, with cardiopulmonary bypass that I mentioned earlier, it's very important to have CT angios on these patients to make sure there's no anomalous vessels and to make sure that the aorta is such that it can accept this balloon. The balloon itself is a balloon that occludes the aorta as you heard from Dr. Bethencourt earlier. But there can always be a leak around that balloon. And if that balloon doesn't sit fairly stable in the patient's ascending aorta, and if it moves back and forth and back and forth, unfortunately too much blood flow gets into the field and interrupts the whole cardioplegia process and their ability to do things endoscopically. I think the other things that are important to note with endoscopic surgery is that ahead-of-time we are consenting our patients for other things we may need. And certainly the success rate with this type of procedure is in the 98-plus percentile which is certainly

standard for this type of surgery regardless of your approach. But you may need to do other things that are different in patients. You may need to turn an endoscopic procedure into a port access or get the patient on regular bypass if need be. I mean, the most important part here in any of these procedures is to make sure that the patient's safety is respected number one and that the brain, vital organs, and heart muscle in general are protected with adequate systems. So it definitely is worth taking a lot of time to make sure up-front that everything is stable hemodynamically with the patient. And if it takes a little bit longer, that's just what needs to happen from patient to patient. How we doing, Danny?

00:19:10

DANIEL BETHENCOURT, MD: Okay, we're adjusting some of our monitoring lines. What you see on the video screen is the aorta right in the center which is whitish with a bit of glare. And then the right atrium is right in front of you there. The heart is just about to stop beating. And we're giving solution into the vein of the heart, the coronary sinus, and we're infusing it into the heart that way to keep the heart stopped and safe for us to work. I think we've got things somewhat stable so now we can, um.

00:19:49

REX WINTERS, MD: That heart looks a lot slower than yours has been over the last five minutes.

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DANIEL BETHENCOURT, MD: I'm sorry. I couldn't hear you.

00:19:53

REX WINTERS, MD: I said that heart looks a lot slower than yours has been over the last five minutes.

00:19:57

DANIEL BETHENCOURT, MD: Yes. Right. It's now completely stopped. And we are completely on the heart-lung machine. We're supported entirely by the heart-lung machine at this point.

00:20:08

REX WINTERS, MD: Are you near a position where you can show the da Vinci or whatever your staff and your people you got surrounding you?

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DANIEL BETHENCOURT, MD: Yes, I can. Should I just go ahead? These are all the arms of the robot. There are four different arms. This is a camera arm. And you can see it moves the video picture. And that's the central place that we use to guide us. This is the left arm of the robot and the right which are the two main instruments that we use for manipulating the heart. You'll see me using those all the time. We have a separate working port here which is another small porthole for Dr. Charles Murphy, who is my bedside surgeon, to work in tandem with me in doing the procedure. And you'll see him coming in throughout the procedure. He is equally or more active than what I do. And then there is a separate fourth robot arm here which we use for the dynamic atrial retractor. And this has already been placed in the chest. And we will use that to hold the heart open and position the heart in the place where we want to be able to see the valve. And the nice thing about having a robot arm for this is that we can move this any number of ways during the procedure to help us see the valve most optimally. We are actually ready to open the heart and look at the valve. Pull two liters through the retrograde.

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FEMALE VOICE: [Unintelligible]

00:21:37

DANIEL BETHENCOURT, MD: Pull two liters through the retrograde.

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REX WINTERS, MD: And just for the audience, it may look like Robin Hood has come to our cardiac OR with all the different arrows that you see in that chest wall. And it's hard to believe that that is actually minimally invasive. But you'll be impressed by the fact that when this is all said and done, the amount of soft tissue damage that's been done to the chest wall is really very minimal. The incisions are very small, and they heal up very, very quickly. Dan, can you comment a little bit about the use of CO2 and those kind of things with these kind of procedures and what it adds to the procedure?

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DANIEL BETHENCOURT, MD: Yes. We're working in the chest cavity. There you have a little better focus. We're working the chest cavity, and the chest cavity is infused with carbon dioxide. And so as a result, the carbon dioxide which is a very dissolvable gas, a very soluble gas is the only thing the inside of the heart sees as far as gas as opposed to nitrogen which is in the air. And the nitrogen can result in bubbles that can go into the bloodstream. Carbon dioxide, if it goes into the bloodstream, is very soluble, it dissolves very easily. And so it doesn't create any damage downstream - particularly in the brain. So we think that this makes this procedure even less invasive or traumatic than it otherwise might be.

00:23:02

MALE VOICE: [Unintelligible]

00:22:04

DANIEL BETHENCOURT, MD: Yes? Now we're going to trade instruments here and set up a scissors so that we can open up inside the heart. With my left instrument here I can show you that this is the right atrium right here. This is the supra vena cava, the large vein, draining into the right atrium from the head and the upper body. And we're putting a scissors instrument in. Now we're going into the left atrium which is in the back. A question I answer almost every day on these patients is: "Why are you operating on the right chest when the heart is on the left?" But in fact the left atrium is actually in back of the heart, and it is more easily accessible from the right because the main part of the heart, the ventricles, are out of the way. So that we'll be going right in front here in this area into the left atrium and expose the mitra valve.

00:24:12

REX WINTERS, MD: And Danny, the patient that's on the table? Are they position at an angle that allows you to get those port accesses in a little bit easier?

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DANIEL BETHENCOURT, MD: Yeah. You may have seen when I pointed them out that they're slightly angled to the left so that we can optimally place the robot arms for the maximum flexibility and also so that the bedside surgeon, Dr. Murphy, can work through the working port incision reasonably comfortably. He is, if you had a camera on him, you'd see him dancing around the robot arms quite a bit because he really has to work around all of these different other appliances and essentially do half of the procedure with me.

00:24:53

REX WINTERS, MD: He says that he does more than half.

00:24:55

DANIEL BETHENCOURT, MD: He probably does do more than half. I wouldn't take that away. He certainly works harder in some ways. I, as you'll see, work almost entirely with two instruments. I use the scissors here briefly and then go back to a needle holder. And those will be the two instruments I use for 90% of the work. He is constantly putting in other instruments and sutures and tying sutures as part of the procedure when we need that. We're having a little issue here trying to put the other instrument in place and trying to solve that.

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REX WINTERS, MD: Any contrary indications, Dan, to this approach?

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DANIEL BETHENCOURT, MD: Well, if the patient's had scarring in the right chest from a previous operation, then it is more difficult, and we don't generally recommend it. If the patient needs two valves, one of the more common things that happens - even with referrals from physicians - is that often one has the aortic valve, I've got the aortic valve and can you replace it with a robot? And currently, those techniques are being worked out, but currently, that isn't something that we're doing. Of course if a patient needed a double valve that would be the same situation. But we can do tricuspid repairs and replacements, atrial septal defect closures, and left atrial myxoma removals very easily with the robot.

00:26:20

REX WINTERS, MD: And since you're intubating primarily in the left lung and keeping it inflated, you can still do patients with partial lobectomies, you just have to be more cautious with the cardioplegia? Or how does that work?

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DANIEL BETHENCOURT, MD: What we would do is use more heart-lung machine. That first section of the procedure I did without the heart-lung machine - opening the pericardium and getting everything set up and ready - that can be done on bypass with the heart-lung machine. Okay. That can be done on bypass, and we would do that if the patient's left lung wasn't able to handle breathing for him. It would be a little more dicey to do it if there was a patient without a portion of the left lung like a lobectomy. That would be a tough situation.

00:27:03

REX WINTERS, MD: I think while you're getting your instruments in place there, I know that we had talked about perhaps you're going to be performing an endoscopic ablation of the atrial fibrillation. You want to just mention a few words about atrial fibrillation ablation endoscopically with or without mitral valve repair associated with it.

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DANIEL BETHENCOURT, MD: Yes. We are able to do a robotic atrial fibrillation ablation in the patients where that is the only problem by going outside of the heart and doing a burn - it's a linear microwave burn of the atrium. And what that does is it creates a conduction block. And that conduction block prevents the atrial fibrillation from leaving the area that it originates and affecting the rest of the heart. In these cases, we'll do the same procedure from the inside. And what we'll do is put a microwave probe and heat the tissue - heat a line of tissue - internally. And that will create a block.

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MALE VOICE: [Unintelligible]

00:28:09

DANIEL BETHENCOURT, MD: Yes. That will create a block and, in general, prevent the atrial fibrillation from occurring. The success rate of that is anywhere from about 75% - 85% depending on the patient's pre-op substrate. We're setting up our right instrument here and seeing if... Okay, that worked. We're getting some feedback from the robot that the right instrument was not being received properly. And now the left one - we switched the instruments just to try and see if we can solve this.

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REX WINTERS, MD: I thought you were good enough, you could just do this with one hand and one instrument.

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DANIEL BETHENCOURT, MD: Yeah. [Laughs] Well, we think that the robot will allow us to be more ambidextrous. We can do things with our left hand that we normally don't in standard surgery. It certainly has the positioning capability, but I haven't found that I'm a lot more ambidextrous with the robot than I was before.
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REX WINTERS, MD: Well, I keep on telling you that all you've got to do is get that sidecar if you need another set of hands, and I will be available.
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DANIEL BETHENCOURT, MD: Yeah. I know. We'll get the sidecar and two more arms and try to stay out of each other's way. Let's see... Yeah, we're having...
00:30:03

REX WINTERS, MD: While you get your instruments all fired up and ready to go, you know, it strikes me like in most areas of our field, the advancements that can take place with an approach and equipment like this - this patient has class III - IV heart failure as the atrium is excessively dilated and refractive atrial fibrillation - if we could reduce the risk of standard valvular surgery, whether it be repair or whatever, down from the standard, old values - especially in the young patients with sternotomies and partial sternotomies and those kind of things - it strikes me that perhaps there is going to be a trend to wanting to repair some of these annulus early versus waiting to the extreme end of maximizing medical therapy that in this young patient population and oftentimes doesn't work. Have you seen any of that coming out with the folks who have been doing this a while, Dan? Are they using it in patients earlier-on in the course of disease?
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DANIEL BETHENCOURT, MD: Yeah, I think so. I think that for both patients and for the surgeons doing these procedures. This procedure is safe. It's minimally invasive. The patients can be back to work. And it has a very minimal impact on their life. And it really affects the timing as to when they will have the procedure and when we will recommend it. And certainly recently, the data from Mayo suggests that if patients just have severe regurgitation without symptoms that one might consider doing a repair procedure early. In some programs, the robot has allowed the surgeons to have a higher rate of repair. They've increased their actual repair rate. We have already a 90 - 95% repair rate for regurgitation patients since so I don't expect any major changes in that. But in some programs, the repair rate has improved from in the 50 - 60% to the 90 - 95%. And in those cases, the robot has made a huge impact on the numbers and types of patients that one would recommend such as those asymptomatic patients. Okay, we're opening the left atrium. And this patient has a particularly large left atrium.
00:32:18

REX WINTERS, MD: Okay, yeah, I think we are going to need to do that.
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DANIEL BETHENCOURT, MD: Where's that sidecar? I would still keep an "Off" Button for the microphone for you.
00:32:38

REX WINTERS, MD: It looks like you're all the way in the heart, Dan. Can you point out the structures that we see in the field here?
00:32:44

DANIEL BETHENCOURT, MD: Yeah. I'm opening the left atrium, and it's very large. And that's why I'm making a large opening here. This is a vent device which we actually may not need real soon. But we're going to do the maze procedure so it'll be helpful. So now we'll drive in here and look at the valve which you see at the very bottom. There's the mitra valve. We'll see that a lot better. This is the wall

between the left and right atrium. And I'm going to get my retractor with the other robot arm.

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MALE VOICE: [Unintelligible]

00:33:23

DANIEL BETHENCOURT, MD: Yes. I'm going to take the right and substitute the needle holder, and these will be the two instruments that I use. I've got to mention about the three-dimensional vision because it's amazing to see this at all and to see it as well as we will. But once you see this with three dimensions, you really understand what we're talking about having better vision and control.

00:33:54

MALE VOICE: [Unintelligible]

00:33:55

DANIEL BETHENCOURT, MD: Yeah, I'm going to go get my left atrial retractor in the field.

00:34:02

REX WINTERS, MD: I can tell you as an interventional cardiologist looking at a flat screen, I'm a little jealous of all you can see here by three-dimensional uh...

00:34:08

DANIEL BETHENCOURT, MD: Yeah, if you can see the three-dimensional, you just wouldn't believe it. And there's my retractor. There are my other instruments.

00:34:28

REX WINTERS, MD: So what Dan is doing here is inserting this retractor that will reflect back his incision on the atrial getting better exposure for the mitra valve apparatus.

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DANIEL BETHENCOURT, MD: Yeah. Now what's happened is I've switched my, here at the consol, I've switched my control. I no longer am controlling the needle holder instrument that was on the left then the right. And now I'm controlling this atrial retractor which goes in here.

00:35:05

CHARLES MURPHY, MD: Right where your left light is.

00:35:07

DANIEL BETHENCOURT, MD: Oh yeah.

00:35:09

CHARLES MURPHY, MD: Right there.

00:35:10

DANIEL BETHENCOURT, MD: There's a... Let's take care of that now. Can I have a Gore-tex suture? Dr. Murphy points out that we have an almost, not visible, patent foramen ovale here. This is a flat valve that connects to left and right atria. You can see a little of the blue blood coming through from the right side. So we're just going to take a quick stitch in there to fix it, and this is how we close a PFO with a robot.

00:35:39

REX WINTERS, MD: So I guess that takes away a closure device for me, doesn't it?

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DANIEL BETHENCOURT, MD: Yeah, and if you, it actually, yeah. The EPs also don't like the fact that we close these. They like to be able to come back there and do further EP mapping and all but, all in all, it's an advantage to close it so we don't have paradoxical emboli. So here comes Dr. Murphy with his suture.

00:36:11

REX WINTERS, MD: As the audience knows, just the presence of this PFO, regardless of the mitra valve disease and those kind of things, certainly puts the patient at an increased risk of TIAs and strokes over time so to be able to find this

incidentally and take this completely out of the equation is a huge advantage getting in here and repairing these valves. I think that the one thing that...

00:36:35

DANIEL BETHENCOURT, MD: Yeah, the other end, you can bring it all the way through if you want. Sorry, Rex.

00:36:38

REX WINTERS, MD: I think the one thing that we have to look at in the future as these valve surgeries progress and we get the percutaneous guys in the marketplace, there seems to be a lot of things that can be done with direct visualization and surgery and things like this that you can find that oftentimes you're not going to find with percutaneous approaches and perhaps maybe even you create during some of the percutaneous techniques.

00:37:08

DANIEL BETHENCOURT, MD: Yes, I think if the surgery is minimally invasive and affects the patient very little and we can get very secure procedures, then it begins to make sense versus devices that are less tested or less tried or have potentially more problems even though the device or percutaneous interventions are certainly less invasive than even this operation. But it makes surgery very much of an attractive option. So now this is to show you standard of how we tie sutures. Dr. Murphy is going to tie the knots outside of the patient, and I'm holding the position for the first two knots. This suture is Gore-tex; it's the same thing we use for the artificial chords in those cases where we have to implant artificial chords. And it's got great characteristics because it's very strong and holds really well and it slides very nicely. The one disadvantage is that it does slide very nicely so we need to put a lot of knots in it. But he put the first two throws, and then I can hold, and then he'll put another eight after I've tightened it down as much as I would like. Each set of knot-tying procedures is a combined approach here.

00:38:45

REX WINTERS, MD: Well, I've got to tell you, you make even knot-tying look easy with the instruments that are far away from your hands. It's pretty amazing.

00:38:52

DANIEL BETHENCOURT, MD: Yeah. He's tying them up above and then there's this "knot-pusher" that pushes the knot down and cinches it at the same time. When we do it for our chord replacements, we've got to do numerous knots and knot-tyings. But with this PFO, we just do one stitch like this, and we've got it taken care of.

00:39:18

REX WINTERS, MD: And again, Dan, in your approach when you get to the valve part of this, I think the patient will respect that - what you're doing now to decrease the risk of stroke with that PFO. But on that valve itself, you've elected just to do a ring. Can you talk a little about the ring and what goes into that?

00:39:33

DANIEL BETHENCOURT, MD: Yeah. Yeah, the ring devices are numerous ones, but the key point is that the ring, the patient's own annulus, the ring where the valve sits, is a stretchy structure. And for various reasons, when the valve starts to leak, the heart stretches out, and it makes the valve round instead of oval. The native valve is supposed to be oval. And what the ring device does is to restore the normal shape. That's all it does. It leaves the patient with her own valve, and that valve will function better than any valve we could ever implant. Now cutting we do from the outside...and that's that. And now we switch back to the protractor arm here. And I'll put this in place.

00:40:35

REX WINTERS, MD: And if you could just give the audience an idea of a valve leaflet, Dan, versus annulus versus chordae.

00:40:42

DANIEL BETHENCOURT, MD: Yes. We'll go down there and look. This is what I described to people as having three dimensions - one of the more amazing things about the robot. To me, this looks like I just opened a garage door. And then you go inside the garage and there's a mitral valve in the back wall of the garage. It's magnified visualized. These are the leaflets of the valve here - the flaps that are supposed to close. Can we pull this retractor, this section out a little bit? These are the muscles - the specialized muscles that attach to the heart. I guess we do need it. Sorry. Thank you. And these are the chordae - the native, the patient's own cords which sometimes we have to replace because they're elongated. And so the valve leaflet itself is attached to these two muscles. Each of the two leaflets are attached to those two muscles.

00:41:43

REX WINTERS, MD: And is it common, Dan, and in general mitral valve disease for one leaflet to be more affected than another?

00:41:50

DANIEL BETHENCOURT, MD: The most common leaflet that gets affected is the posterior - the back leaflet. And we'll see that more in a minute as we head towards the suture. I think we're going to take an incisor and start to cise the valve. Why don't we give retrograde cardioplegia. We're going to repeat our infusion of the cardioplegia, the protective solution. But you can see here that the valve already is stretched out. This is the back leaf but it's way, way down here. And it should be up here floating together. So you see this big kind of "smile shape." It's very, very abnormal. When we finish we should restore this shape back to an oval-type shape. And, really, I can't show it because it's so deep. But that patient's native annulus - the ring down here - that should be up here. And we'll restore that positioning with the ring.

00:42:50

REX WINTERS, MD: Overall besides the annular dilatation, there might be a little thickening of the valves. But the chordae look pretty intact.

00:42:56

DANIEL BETHENCOURT, MD: Normal, intact. Yes. Short. And reasonable size. They're not too thinned out or anything there. There's one of the native cords of the interleaflet. The interleaflet, to me having seen a lot of valves, looks a little bit short from here to here. A little bit short. And then again there's the stretching of the valves. So there may have been a congenital abnormality with this valve rather than the usual degenerative disease that we see. Okay, so we'll start with the 25 ATS cisor. So we'll take a cisor which is a disk, a plastic disk. We're looking to measure the distance between here and here. Because these are the trigones - or the toughest structure of the valve. And it's just the size reference point that we use to tell us what size ring or valve ring we want. Just wait until the device comes in. Now meanwhile we're infusing the cardioplegic solution, the blood potassium solution, to preserve the heart. Every fifteen minutes we give the heart another dose which gives the heart oxygen, cools it further, and keeps it stopped, keeps it arrested - all of which contributes to preserving its function. And you saw my stocking feet here that I have a number of controls that I use, we use on our feet. And really I'm able to tell much better without shoes. These movements of the camera - the repositioning of the camera - are done with the feet. The focus is a foot control. And then... Are you done? Austin? When we have cautery, we want to turn on the... Yes, 25 please. To burn a blood vessel, that's a foot control as well. And then switching between the retractor and this instrument - the right hand instrument - is done with the feet as well. Here comes the sizing disk into the fat from the surface of the patient. We'll take that out of there in a second. I'm just

"guesstimating" the distance between the trigones. And actually this one looks very, very good. In other words, the distance versus the other... Let's take that. Is this the smallest size or is there a smaller one? There's a 23? I think we'll take that 25. Take a 25 band. We're going to implant a 25 band.

00:46:04

REX WINTERS, MD: So is that a one-to-one sizing, Dan, with the measurement device and the...?

00:46:09

DANIEL BETHENCOURT, MD: Yeah. That's the intertrigonal distance, and it's a millimeter size. The "guesstimate" part of it is that we also try to get a sense for the distance between the front of the valve and what will be the back and to determine the ultimate size we want the valve to be. And we sort of put that all together with a lot of experience, and you can "guesstimate" a reasonable estimate of size. So instead of sutures, one of the big advances in robotics that we use to our advantage is the use of these clip devices - these nitinol clips. So instead of stitching this valve in with individual sutures and tying 10 - 12 knots on each one, I'll show you how these clips work here. Yeah, we could use a few more minutes. Okay. Thank you.

00:47:14

REX WINTERS, MD: Did you want me to in 7 minutes say goodbye to the people in to the people that are watching?

00:47:23

DANIEL BETHENCOURT, MD: Yeah, that'd be great.

00:46:04

REX WINTERS, MD: So the nice thing about nitinol, Dan, you've used it here now in this case and in other places. And we use it a lot in the lab, too. It comes pre-shaped. So it'll always try to go back to its original form.

00:47:39

DANIEL BETHENCOURT, MD: Right. And so now this... I'll take the ring next. Or the band. So this clip device has got a needle on either end, a release mechanism, and then this blue part here is the nitinol clip. So this is the device, the ring device that we're going to use. Here's the position it's going to go. And it's a band so it's not a full ring around. And we'll put this in at this tip. And we'll put the other tip in a minute. Must be one of the last hospitals in the world to have an overhead paging system. Didn't hear the page.

00:48:31

REX WINTERS, MD: I haven't heard your name paged yet so...

00:48:32

DANIEL BETHENCOURT, MD: Stat to the emergency room, yes. So we've passed the other ends through here, and then, once the nitinol part is in, we grab this release mechanism, pull it, and then the nitinol loops itself and secures the clip.

00:48:56

REX WINTERS, MD: And again, that nitinol, like most nitinol products is a pre-formed shape that basically once you release it, it's already in pre-form shape and there's no way to change that, is that correct?

00:49:06

DANIEL BETHENCOURT, MD: Correct. Yeah. So this will pull it tight up against there. And this will be one loop. And this will be the center of a suture so now instead of tying this, we can just release it and give it back. And we'll take another one for this other corner. Dr. Murphy will bring one down as he takes this one so we can minimize the numbers of passes.

00:49:44

REX WINTERS, MD: Once the ring's in place, Dan, how do you test the competency of your work? When do you know whether you've closed the valve in the right orientation and the right degree?

00:49:53

DANIEL BETHENCOURT, MD: We can squirt it with some saline is one method. That works pretty well. But in these robotic cases - when the patient is on their side - it's a little difficult to test. And when we use the saline, we actually introduce a few nitrogen bubbles. And so we can test it to see what it looks like. But we try not to do that too much if we can help it.

00:50:33

REX WINTERS, MD: We should have a pretty good idea just by the orientation or the configuration of the valve, the annulus, and where it comes back to you, I would imagine.

00:50:41

DANIEL BETHENCOURT, MD: Yeah. Exactly. We can really tell from how the valve looks. Besides we rely more and more on the transesophageal echo. The echo is really so accurate that we know today, for example, that there is annular dilatation. That is the problem, and it's extremely unlikely - especially with the echo that we have here at Long Beach Memorial with the quality of it - that we'd find something different. So in most top centers, we're relying more and more on the TE and less and less on direct inspection, I think.

00:51:30

REX WINTERS, MD: And I would imagine that also not only we talked earlier about not only the TE but the CTE angios that these patients need to go through preoperatively. I would imagine the CTE angio may also help with the atrial fibrillation procedure here as well then to make sure there is no anomalous pulmonary veins or various other things that you need to know about going in. Not that you wouldn't see them yourself. But...

00:51:51

DANIEL BETHENCOURT, MD: Right. Yep. Another situation is the supra vena cava. We can have an anomalous left supra vena cava, a persistent left supra vena cava which can complicate matters a little bit and, in some cases, um... We've had one case where we discovered an interruption of the inferior vena cava which prevented us from doing the venous cannula that we normally do. And the patient had no idea that he didn't have a normal cava.

00:52:38

REX WINTERS, MD: And the work-up from a coronary disease status, do you put your young patients through the actual coronary CT part of things, too? Or just the...

00:52:54

DANIEL BETHENCOURT, MD: Yes. We've been using the 64 slice CT angiogram to evaluate coronaries in the younger patients entirely. And then in the older patients, sometimes to screen them and see if they have a large amount of calcium. And if they don't, we then don't use any other study. If they do or if we're at all suspicious, of course we do a treadmill and/or an angiogram.

00:53:24

REX WINTERS, MD: And once this ring's in place and you've moved on to another procedure, postoperatively, Dan, without the atrial fibrillation, is there a need for anticoagulants for any period of time? I mean, obviously with atrial fibrillation you're going to keep this patient on for a little while after the procedure.

00:53:38

DANIEL BETHENCOURT, MD: Right. Yeah. That is something that has changed recently. We, in the past, put these patients on anticoagulation for six weeks or eight weeks. And now with just a ring replacement or just a repair procedure, we

are not using routine anticoagulation in those patients. With atrial fibrillation, of course like you say, we change the situation a bit.

00:54:11

MALE VOICE: [Unintelligible]

00:54:13

DANIEL BETHENCOURT, MD: What?

00:54:14

MALE VOICE: [Unintelligible]

00:54:33

DANIEL BETHENCOURT, MD: I want to take this one here. Okay. Yes, we're just continuing with placing this ring device to attach the ring and reshape the patient's own valve ring. And at this point we're just placing a series of these clips.

00:55:37

REX WINTERS, MD: Danny, is there a set number of sutures you put in? Or are you just kind of eyeballing it while you're in there and whatever secures it...

00:55:44

DANIEL BETHENCOURT, MD: It's really just...we just determine it at the time in terms of numbers. What we are eyeballing or what we are adjusting as we go is we're trying to shrink and reshape the patient's annulus. And we're trying to fit the ring itself in an optimal position. So every time I'm taking larger, you might notice, I'm taking larger bites on the tissue and then a smaller bite on the ring because there's much more tissue than there is ring. So we'll pull this through the nitinol. And so I took kind of a wide bite there but then I'll take a smaller bite on the actual ring.

00:56:58

REX WINTERS, MD: Looks like it's kind of fitting pretty nicely there.

00:57:00

DANIEL BETHENCOURT, MD: Yeah, it's coming together nicely and tends to. Grab this release mechanism here. And we want to twist these so they go out away from the valve tissue.

00:57:17

REX WINTERS, MD: And endothelialization of these rings and these nitinol residual wires takes places like normal tissue?

00:57:24

DANIEL BETHENCOURT, MD: Yep. Yes, over the course of six weeks. So that by six weeks, this is all covered over with the patient's own tissue.

00:57:40

REX WINTERS, MD: So we're safe at two and three months not to worry about antibiotic prophylaxis or...

00:57:45

DANIEL BETHENCOURT, MD: Right. They don't need any further... Although I do tend to, in terms of antibiotic prophylaxis, I do tend to use whether they have turbulent flow or not. I wonder if we should replace this one. I think we probably should. Don't you think, Chris? This one got kinked on the way in. I think that might have damaged the release mechanism. And I don't want to find out after I've got it in the valve. Yeah, let's take that one. But you can see now the annulus is coming up. I'll take my little vent here and put that inside.

00:58:48

REX WINTERS, MD: And in a situation, Dan, where you'd be doing - not in this case - but where you'd be doing leaflets and chordal insertions, do you do all that before the ring? And the ring is then the last part as you come out? Or how does that work?

00:58:56

DANIEL BETHENCOURT, MD: Yes. Yes, we do the chordal work first to give us more room to work inside. And then we do this ring part at the very end. And you'll notice I'm leaving the last half clip connected because it allows me to pull up the ring away from the tissue. And then again more flexibility here.

00:59:52

REX WINTERS, MD: So is the plan that the last suturing is going to take place in the middle of that ring there that you left...

00:59:57

DANIEL BETHENCOURT, MD: At the bottom. Yeah. Can we pull the vent back a little bit? Sorry. Actually, I'll get it myself. I'll get it. It's good. 15 okay. Got it. Sorry. Pull the vent back a little bit. Let's take that little piece of fat material.

01:00:40

REX WINTERS, MD: What happens if you get a leg cramp during one of these things, Danny? Do you just have to stop the whole thing or what? Get a lot of Gatorade on board before you start one of these?

01:00:50

DANIEL BETHENCOURT, MD: Yeah. I keep a stash of snacks for the breaks because fortunately there are several breaks. But unfortunately once we get rolling here, it's fairly continuous. Now usually the times aren't too long. But a complex repair can be complex. But we know the patient is safe during the procedure so... The heart is safe. The patient's safe. We can do whatever necessary even if there are cases where we have to come back and do some more.

01:01:32

REX WINTERS, MD: While you're suturing in then and finishing up this annulus part, we're not going to be able to show the endoscopic maze live. I didn't know if there's anything else that you wanted to comment on about that part of the procedure that you're going to be getting to later?

01:01:46

DANIEL BETHENCOURT, MD: What we're going to do is just take... Just a second - untangling ourselves here. ...Take the microwave device and just lay it on the surface of the atrium like here where we want to ablate or burn. And then we'll create these burns - just 90 seconds of microwave just like at home in the oven.

01:02:29

REX WINTERS, MD: So are you going to be ablating from inside the atrium? Or outside the atrium in a standard endovascular approach?

01:02:36

DANIEL BETHENCOURT, MD: In these cases, we go from inside the atrium to the outside. But we are making these lesions away from the back of the wall of the heart. Can we push that in there? There we go. Okay.

01:03:06

REX WINTERS, MD: So I guess in combination with mitra valve procedures that you're doing since you can give both inside and outside the success rate of this type of endoscopic ablation for atrial fibrillation has to be at least a little higher than the standard, plain endoscopic thoracic ablation that you'd do.

01:03:23

DANIEL BETHENCOURT, MD: It definitely is because we can... In those cases, we have a lot more control over the positioning of the lesions that we want.

01:03:39

REX WINTERS, MD: You know, it's interesting. This is the first time that we're able to actually see that part of the annulus. She pulled it up already to finally get it in view.

01:03:46

DANIEL BETHENCOURT, MD: Exactly. But as you can see, you can see it. Everyone at the bedside can see it. Everyone in the room can see it. So fairly soon with a good team like ours, everybody in a sense is participating because there are little segments of the procedure that you're not seeing that is part of everybody else's job that they tailor to what's going on in the operation. Can we pull that sucker back a little bit? All right.

01:05:00

REX WINTERS, MD: Image finishing these things off trying to get the instruments back at that angle and that far of a... Posterior is really the challenge, isn't it?

01:05:09

DANIEL BETHENCOURT, MD: Well, it just depends on the case and depends on the positioning. In this case, this annulus, as we all noticed, is very displaced. And so I keep trying to get this all in one bite. But it really isn't happening so we'll do it in two. But yes, we couldn't see that posterior annulus - much less try to work on it. And now as we've gone along, it's very visible.

01:05:37

REX WINTERS, MD: I'm also impressed by the chordal structures in the background as they start to take their normal shape versus what we saw earlier and how they look like they're really in very good shape given the degree of mitral regurgitation this lady has.

01:05:51

DANIEL BETHENCOURT, MD: Mm-hm. Yes. Okay, cut it. Hold on a second. We're going to almost be off-- offline here. Okay go ahead and give [unintelligible] please.

01:06:19

REX WINTERS, MD: Any other thoughts, Dan? We're going to be off-live in a couple minutes.

01:06:23

DANIEL BETHENCOURT, MD: I guess this is about it. We won't see the very end, but no -- But this is the key part of the procedure. We always put in annuloplasty ring in place no matter what kind of repair we do. And this, if nothing else, supports the repair itself. For many patients, this is all they need. And one thing, as we repair these valves earlier, especially with these minimally invasive techniques, we need less of an operation. And as the patients go longer and longer, the valves tend to stretch out. And then the procedure is more complicated. So I think that because we can do a minimally invasive endoscopic or robotic approach, we will not just get to patients earlier but the success rate should be higher because we're working on patients that have less of a structural problem. Can we have the -- the vent back, please? As you can see that the valve is coming up to the normal position. We need probably two more clips here, and that will do it.

01:07:38

REX WINTERS, MD: Looks like you've made the turn into the home stretch there.

01:07:40

DANIEL BETHENCOURT, MD: Yeah, I think this is it.

01:07:47

REX WINTERS, MD: Again, for the folks in the audience while Dan's putting these last two sutures in place, we're going to attempt to show you the final closure of this valve here live. You can access the video and feed on OR-Live.com. We certainly thank all of you guys for being with us today. It's a pleasure not just from my point of view but I know from Dan's as well for you guys to join us. As Dan mentioned a little while ago, this is a large undertaking with a lot of personnel. And we couldn't do it if we did not have the support staff from the folks working in the OR, whether it be echo or surgical, nurses, techs, and administration support to be able to offer this to our patients here in the Long Beach area. So we're excited about all these new

techniques. I think in this case we've now been able to see why this lady only needs a ring. We've gone through some of the thought processes - both preoperatively and postoperatively. We've given you a good look at what can happen with the pulmonary support systems and how those must be in place to protect the patient. We've specifically... And Dan's been able to reduce this lady's risk of stroke down quite a bit - not only by the atrial fibrillation procedure he's going to do after the valve here is done and the valve fix, but he also found the PFO that he was able to close and take that completely out of the equation for the rest of Live. So I think that this lady's ventricle should be a lot happier. Her rhythm should be a lot happier. And she should be a lot happier for a long, long time, Dan. Any other final comments from your point?

01:09:35

DANIEL BETHENCOURT, MD: Just to echo more than anything we do, this is a team approach. We have the good fortune here at Long Beach to have a superb scrub team, a phenomenal echocardiography, and support staff - anesthesia, every last one. And in this procedure really more than anything that we do, it's absolutely essential. So we've been very fortunate to start up our program and really get off running from the very beginning. We started just six months ago. We've done 40 procedures now. This will be the 41st. And we've been very happy with everybody's performance here on our O.R. team.

01:10:23

MALE VOICE: [Unintelligible]

01:10:33

DANIEL BETHENCOURT, MD: Okay.

01:10:36

REX WINTERS, MD: Well, Dan, I think that we all can see that this valve has changed the configuration to the non-round oval of the valve configuration that you mentioned earlier. It's in a plainer configuration with the other leaflet. One more suture and it'll be closed completely. And I'm sure you'll have a very successful valve annuloplasty and ring repair. So again, I think that you've got a lot of work to still do on the atrial fibrillation part.

01:11:02

DANIEL BETHENCOURT, MD: Right.

01:11:03

REX WINTERS, MD: Again, thanks to the audience for joining us. Again, this is all available on OR-Live.com. It was our pleasure to have you all here at Long Beach Memorial Heart and Vascular Institute. And hope to see you all again very, very soon.

01:11:27

ANNOUNCER: This has been a mitral valve repair featuring the da Vinci Surgical System performed from Long Beach Memorial Medical Center. OR-Live makes it easy for you to learn more. Just click the "Request Information" button on your webcast screen and open the door to informed medical care.

01:11:53

[end of webcast]