

**ROBOT-ASSISTED MINIMALLY INVASIVE
CORONARY ARTERY BYPASS SURGERY OPERATION
PINNACLEHEALTH HARRISBURG HOSPITAL
HARRISBURG, PA**

00:00:08

JOHN PENNOCK, MD: Welcome this evening to PinnacleHealth Harrisburg Hospital campus. We are going to witness a robot-assisted minimally invasive coronary artery bypass surgery operation. My name is Dr. John Pennock. I'm going to introduce you shortly to Dr. Chris McCarty, who's in the operating room and has started the procedure. This procedure takes approximately six hours to do, but we're going to condense it to about an hour, so that you see the important parts of the procedure. So we'll go into the operating room to see Dr. McCarty. Hello Chris.

00:00:49

CHRIS MCCARTY, MD: Hi John. How are you?

00:00:50

JOHN PENNOCK, MD: Oh, good. Would you like to explain to the audience what you're starting to do and maybe give a little background on the patient's condition?

00:00:58

CHRIS MCCARTY, MD: Sure. This is a 59-year-old gentleman who has been really very healthy otherwise but several months ago started to develop some chest pain. He went to his family physician, who did a stress test, which was markedly abnormal, especially in what we call the lateral wall, or where the circumflex artery is distributing blood supply to. He then went for heart catheterization, which revealed him to have 100 percent occlusion, or a totally blocked circumflex artery, and a tight lesion, an 80 percent lesion, and a very dominant diagonal. That's the artery on the front surface of the heart. And his left anterior descending, which is really the main artery on the front surface of the heart is what we call atretic, or very small for him. He was born that way and he has been living off of this diagonal, which is serving as his left anterior descending. Because his lesion set is on the left side, he's an ideal candidate for a minimally invasive operation with the da Vinci assistance of taking down the IMAs, or the arteries from the chest wall. So, we're going to get started here. In essence, when we do conventional bypass surgery, we go through the sternum and there's a large incision that would be made and I have a line drawn across here, just for me, to help topography on the patient. So we would normally go through this incision. The plan for this patient, however, is to use the da Vinci, which is this machine that we've gotten started ready for the surgery, and we would need to make at first three port sites. So the first one here, right under the nipple is for the camera port. The camera is very interesting, because unlike regular endoscopic surgery, this is three-dimensional, which most endoscopic surgery is two-dimensional, so it's really going to help us to be able to see all surfaces and work in the chest very comfortably, which is usually not a circumstance that can be done. You also have two other port sites above and below and they will serve as my left and my right hands. So we will start to do the surgery at this point, get the ports in, and then we'll take a look inside. Just because I have to, conventional open-heart surgery, you would use a heart team. Most people rotate through and they do fine.

Robotic surgery requires a little bit of expertise and so I really feel I need to because I have to applaud these people who have been with me for the past two years, helping me to do what is my dream, not necessarily their dream, but my dream to do this for patients. So, here we go. My physician assistant is [Aaron Murstoka]. Head nurse of robotics is [Sara Harrick]. And the rest of these girls are going to hide, but I will introduce them if they're not willing to come forth. There's [Mandy Simpson]. There's [Wanda Rowe]. Way in the back is – there she is. She's driving the robot, is [Deb Wickerd]. So, having started, we'll get started ourselves. The first incision that's made is the one for the camera port. This one's just a little bit larger because the camera port is larger. [Aaron] and I are going to be doing a dance, as well as [Sara], for the next couple of minutes to get this in. I should also explain, there is the need for some fairly different anesthesia here, and [Todd Schafer] is our anesthesiologist. Take the – When you gain access into the chest, you need to go more or less more posteriorly because you are around the fourth interspace, and the heart is right there. If you go in with any sharp instrument, you could potentially do some damage to the heart in getting in, so you really want to be as blunt as possible. Now this port gives us access to the chest cavity and it gives the camera an opportunity to come in through the port. CO2 is being blown into the chest to help decrease the volume of the lung, allow the heart to be pushed away so that we can work and do what we need to in a very close space. It's not like the belly where the abdominal wall can increase to accommodate what needs to be done there. Here we're really in a close space because we've got ribs and everything is really a minimal space. Can we turn the lights down, please? Lights on. Camera lights on. Yup. First thing that we do is we take a look around. Focus please. The first thing that's critical obviously for us to do is to take a look around and see if we can see the internal mammary artery, which we did see but we were going to get better visualization on that now, hopefully. It's still out of focus. Is it getting better? Okay. So, we can see that the lung is retracted back and very flat. Can we come up now? In through here you're seeing the aortic arch and you can see the IMA coming in through here. This is the left IMA here. This is the mediastinum that is shoving itself. Now we take and span the camera down as well so we get a better idea of what the chest is like. There's the heart, obviously. That's the anterior wall that is beating in front of us. He's got a fairly small chest and it's got a fair amount of fatty tissue within it as well, but I think we'll be able to work around that. It comes down toward the lateral wall. Anyways, we're going to try to get our other ports in here. That's right. The whole time that you're doing the robotic portion, you really have to be very cognizant of where your cannulas are placed.

00:09:04

AARON MURSTOKA: Can you adjust the focus? Mandy, focus please? Focus.

00:09:13

CHRIS MCCARTY, MD: I don't know if you can see how small these stab wounds are but they're extremely small and as you can imagine, this is a big advantage over the big sternotomy incision that can be created. The other reason this is a nice procedure, let's say that you've got a patient that just needs bilateral IMAs but may need to go to the right side of the heart. I didn't tell you this, but on this gentleman, he's got a very dominant right and it's not diseased. This surgery at this point I think is really ideal for left sided revascularization. For the right side, I think it's a little dicey yet because you really have to manipulate the heart around and that's kind of tough.

00:10:01

JOHN PENNOCK, MD: So Chris, where are you at this point in the surgery?

00:10:06

CHRIS MCCARTY, MD: Okay, what we did was we had to create a plane to allow for the left instrument arm to come in, so I had to cut down some of the fat robotically inside so that I was using just my right instrument arm to cut that down. Aaron put in a [Schnitt] instrument or something so that I could visualize the plane that I was in so that we could bring the left instrument arm in as I was cutting down the fat. At this point, we're good with at least the port placement and we're going to try to get the instruments back to where I need to work.

00:10:51

JOHN PENNOCK, MD: Chris is now taking her place at the royal seat of the da Vinci device, where she's going to insert her fingers into control devices which operate the arms.

00:11:04

CHRIS MCCARTY, MD: The camera port needs to come back a little bit. Yes, but I need to have both at the same time if you can. Okay. Yup, much better. Oh! Hold on a minute. And it really helps to get all of this fat down to help you visualize and also to get the heart out of the way while you're working. It helps to drop the heart down further into the thoracic cavity.

00:12:09

JOHN PENNOCK, MD: But it is amazing to see the robotic arms move electronically. It's quite modern.

00:12:21

CHRIS MCCARTY, MD: And it's an instant motion. There's no delay in the recording of my motion to the motion of the machine itself.

00:12:47

JOHN PENNOCK, MD: You might be able to tell that the one arm acts like a forceps, the one she just picked that fat up with there. The other one acts like a Bovie electrocoagulation machine that coagulates as it dissects the tissue away, so that you don't see any bleeding.

00:13:07

CHRIS MCCARTY, MD: Hopefully. Now, what you can see here as I'm coming through all of this fat is you're starting to get the presence of some vessels. I will try to demonstrate that a little bit better, but as I come through this film right here, I think you're starting to get the essence of the internal mammary vein here. And you can see the pulsation of the artery and through here, and that is the internal mammary artery. So I'm going to take some of this fat down here and hopefully once I get that down and a little bit better exposure to what I need to be doing, then we'll go and take the fat off of the heart so we can get exposure to the surface of the heart. Yes this is.

00:14:11

JOHN PENNOCK, MD: Chris, where are we now in the surgery here?

00:14:14

CHRIS MCCARTY, MD: Okay, well what I had to do was – this gentleman had a tremendous amount of fat, so just to get orientation again, remember I took the fat away from the chest wall, and right here, although you may not see it on the two-dimensional screen is the IMA, and I can see the pulsation. I needed to take down all this fat on the pericardium and there is still some there but at least we can start to see what is the beginnings of the pericardium. I actually did open up a little bit here, so what we're going to do is do a pericardiotomy, which is to open up the pericardium to get a view of the surface of the heart.

00:15:18

JOHN PENNOCK, MD: Chris, we have a question about the feel and touch of what you're doing.

00:15:26

CHRIS MCCARTY, MD: It's funny. You don't – your senses take over in a different way. What used to be a tactile thing, and you know what I'm talking about, as far as feeling the pulsation, seeing it and knowing how much give it's going to have, are gone. But it's more visual at this point, so everything that I'm doing, I know exactly how much I can stretch things just by my visual field here.

00:16:00

JOHN PENNOCK, MD: The operation of the da Vinci, do you have much feel – You don't have the sensation of pull, you have the visual sensation of pull. Is that what you're saying?

00:16:14

CHRIS MCCARTY, MD: Correct, yeah. So here I believe you can see right here, I'm pointing to it with my cautery, is what I believe is his dominant diagonal. Okay? That's where we're going to bypassing to.

00:16:28

JOHN PENNOCK, MD: That's one of the two vessels that need bypass.

00:16:30

CHRIS MCCARTY, MD: That's correct. The other one will be more posterior, but I will identify that at the time of surgery. In general, because only the right lung is inflated, the heart will rotate over toward the left, so what you think is the anterior wall really becomes more lateral. So even a left anterior descending may be seen in this plane, whereas John, what you're used to is seeing it way up high up in through here.

00:16:56

JOHN PENNOCK, MD: Yes.

00:16:57

CHRIS MCCARTY, MD: So, there is a change in where you will see your arteries, and you have to get used to that as well. So at least we've seen the vessels. I've identified at least one of the major vessels that needs to be bypassed. So I feel more confident that I can go ahead and start taking down my arteries. So I'm going to start making my path toward dissecting out the mediastinum. Now from a robotic standpoint, what we do in conventional surgery is generally we take down the left IMA first, and then if we're going to use the right IMA, we will take that down second. From the robotic standpoint, you have to go after the right IMA first because as you can well imagine, if I were to take down the left IMA and have it draping across the field where I'm going to be marching back and forth with my camera and my two instrument arms, I could easily damage that, and so you don't want to be doing that. That will be the second part of the procedure is to take the left IMA down. Now this gentleman obviously has a tremendous amount of fat and so we're going to have to dissect all of this out to go more medially, or I will be going, as I said, under the sternum here.

00:18:48

JOHN PENNOCK, MD: Chris, how would you describe the learning curve for using this device in cardiac surgery?

00:18:55

CHRIS MCCARTY, MD: Well, I think it's really steep because I've always kind of equated it to being the pilot on a navy air carrier. I think that to try to land a plane on a moving ship is extremely difficult and that's what we do here is we're trying to operate on things that are moving. I think that the da Vinci has been extremely helpful for urologic and gynecologic surgery, even for mitral valve surgery. At that time, the patient has to be on what we call the heart-lung machine, or a cardiopulmonary bypass, so it's a still field. So I don't know that from the standpoint of robotic mitral, if you're a proficient mitral valve surgeon, that the learning curve is quite as steep as it is for revascularization. Revascularization, I think, is very tough

just because I optimally think that you need to be a proficient off-pump surgeon, meaning a beating heart surgeon. To me, I don't think there's any benefit to be doing this kind of surgery and then putting the patient on the heart-lung machine in order to do your anastomoses. It kind of defeats the whole purpose. So the learning curve is very, very steep. I would say that and my merry band of men and women here would probably say, it's only been in this year that there's been more confidence in being able to do any kind of patient that may come through. As you can see, the camera is actually coming up above the heart. You always have to be cognizant of that as well.

00:20:42

JOHN PENNOCK, MD: For the non-cardiac surgeons in our audience, Chris, can you describe the sizes of the mammary arteries for us?

00:20:50

CHRIS MCCARTY, MD: Well, I think that at this point, looking at his, it definitely looks like it's a great than two-millimeter vessel. It looks like a good size vessel. The thing that's very nice about this procedure is that you're operating in a field and it's fairly atraumatic and I've got very high magnification. So we're talking a magnification of 10 power and my loops for doing the anastomoses, or for standard conventional surgery, are four and a half power. So there's a huge change in the amount of magnification that I'm carrying and it really helps to do this fairly atraumatically. Now I've come across the mediastinum here, to some degree, I've still got places to go. The last thing you want to do is to create just a hole that you work in. You have to go all the way down and make sure that you're attaining where you need to.

00:22:10

JOHN PENNOCK, MD: Chris, where are we now?

00:22:12

CHRIS MCCARTY, MD: Well, we've gone across the mediastinum and right here you can see the right lung coming up and down into our area. Still a lot of fat that needed to be dissected back, but I pointed out the left internal mammary artery, and this here is the right internal mammary artery. So, we're going to try to start taking it and see how we go. It may be a little bit more difficult, just because the pleura is coming really up and butting against the space I'm working in, but we'll see what we can do. You have to get through that fascial plane first, and from my standpoint robotically, and even when I do my conventional surgery, I take my IMAs as a free IMA. It's not a pedicled graft, which means it does not have the veins associated with it. I try to take it free of that. It allows me to have a little bit more length and it protects the patient as well from any adverse effects, potentially, of infection. The vein does help to protect the sternum. So as you can see, there's the beginning of the dissection. You can pretty clearly see that the artery will come fairly freely.

00:23:42

JOHN PENNOCK, MD: We're mostly looking at veins right now, is that correct?

00:23:45

CHRIS MCCARTY, MD: That is correct. But I think you can start to see what I'm seeing here, which is I'm freeing up the vein and this white vessel here is actually the artery.

00:24:13

JOHN PENNOCK, MD: Just to put things in perspective, we're looking at a vessel that's about two millimeters in diameter. That fibrous tissue, how would you describe that? Tendonous tissue?

00:24:43

CHRIS MCCARTY, MD: That's just like a fascial layer, you know. It helps me, though. I'm glad he's got pretty good strong tissue, because when you don't it becomes a

little bit more difficult and dicey to take down the right IMA as a free graft. As you can imagine, I'm pulling down on it to give me the visualization I need to get into the right plane. There are branches here that I'm cauterizing. They're venous branches. You can see it's a fairly large branch here that's coming off of the vein, so that's what's causing this little bit of bleeding.

00:25:56

JOHN PENNOCK, MD: Chris, would you say there's less blood loss with the robotically assisted procedures?

00:26:01

CHRIS MCCARTY, MD: Yeah, there is. You know, as you can well imagine, you're under pretty high magnification, you can see the branches as you need to, and you do have less bleeding. Of course you know as well as I do John that most of the bleeding comes from the sternum. It doesn't come from anything else. So if you're able to do this surgery without breaking the sternum, then you're going to have necessarily less blood loss.

00:26:37

JOHN PENNOCK, MD: Do you ever have to use clips?

00:26:39

CHRIS MCCARTY, MD: Yes I do and I need to get better visualization of the branches before I do that, which is why I'm kind of taking this all down right now. The clips are a little bit tricky. The branches are larger and I don't feel comfortable to just cauterize across them because I'm also worried about injury to the artery as I do that. So on the larger branches I try to place clips. Clips are – for the audience that may not understand – basically they are like little staples that we use on major branches of arteries or veins to prevent bleeding from occurring. Yeah, that would be great.

00:27:45

JOHN PENNOCK, MD: Dr. McCarty, we spoke to one of your patients yesterday who had the procedure done robotically and this is what he had to say about it.

00:27:56

PATIENT ON VIDEO: The discussion I had on how the operation – or what choices I had on that surgery – I talked to Dr. McCarty, who was my surgeon, and she explained to me that there was a possibility of doing this surgery using some robotic equipment and that doing it that way would give me much faster recovery and be much less traumatic and that I was a good candidate for doing that type of surgery. So that was fine with me. I elected to do that, seeing that other people I've worked with who have had that conventional type of bypass where they've had their sternum split open and seeing the lengthy recovery time and things like that was not really appealing to me, although if that's what the alternative was, that was the route we were going to go, because the ultimate goal being my good health in the end of this process. So we did the robotic surgery and I'm incredibly pleased with the whole situation.

00:29:08

JOHN PENNOCK, MD: We talked to another patient of yours who had surgery done robotically and he said that the recovery was remarkable.

00:29:17

PATIENT ON VIDEO: So, my recovery time was – I'm still just about in disbelief about how quickly I recovered. Within a matter of a couple days, I was out of the hospital. But even during the stay after the surgery, I was – my roommate, who was having more of a conventional bypass surgery, I was up walking around while that individual was still in intensive care. I had friends of mine visit me in the hospital, come in, check on my well-being and everything, and in our conversations they were saying, "When are you scheduled to have the surgery?" I said, "I had it yesterday."

They're looking at me like, "We can't believe that you've just had heart surgery." I just had no real appearance of being frail or just really wiped out by that type of trauma. Within a matter of a few days, I really felt good. By the end of that – I had a surgery on a Monday and by Saturday of that week, four or five days later, I really feel like I do now. Although I was certainly under the doctor's advice to take it easy and let nature take its course and heal, but I began the following week to work from my home. I have a profession that allows me with a good computer line and a telephone, I can pretty much work anywhere. I went back to work from home on a limited basis the first week and by the second week I was working full time. I felt as good as I do today.

00:30:52

JOHN PENNOCK, MD: Chris, it looks like you've got the right mammary artery down. Is that correct?

00:30:57

CHRIS MCCARTY, MD: That is correct. For this patient, fortunately, we were able to do it without entering the right pleural space. As you can see, that's still intact. So I've clipped it proximally already, because I'm going to take it as a free graft rather than trying to bring it across the chest wall. So it's clipped proximally and I'm going to show you the full length of it. You can see it's a completely free graft. It has nothing else attached to it. So what we're going to do at this point is I'm going to cut it proximally because we have the clips applied and Todd could you please stop ventilation for me? As you could see, it was a lot of interference...

00:31:44

JOHN PENNOCK, MD: Now you have your forceps and your scissors.

00:31:50

CHRIS MCCARTY, MD: Yup. What's that? Nope.

00:32:01

JOHN PENNOCK, MD: It looks good.

00:32:16

CHRIS MCCARTY, MD: What I'm trying to figure out is if my clips were all the way across the proximal side obviously. Why don't you give me another clip. I don't think I'm all the way across.

00:32:30

JOHN PENNOCK, MD: You want to make sure it doesn't bleed.

00:32:31

CHRIS MCCARTY, MD: Absolutely. Because as you can well imagine and you know as well as I do, even a branch can bleed significantly, so to have a stump bleeding is – No clip in there?

00:32:53

JOHN PENNOCK, MD: I bet you're okay, but it's good to be cautious.

00:33:04

CHRIS MCCARTY, MD: Okay, I will take the scissors please.

00:33:32

JOHN PENNOCK, MD: Very nice.

00:33:34

CHRIS MCCARTY, MD: So I'm going to let that fall. Okay you can start to ventilate again. Thank you very much. Okay, now I need to have a change of instruments here. I need to have the DeBakey in my right and clip in my left.

00:34:05

JOHN PENNOCK, MD: You're going to clip and cut the distal end.

00:34:08

CHRIS MCCARTY, MD: Correct. Okay, another clip please. One more please. I think you can pretty well see I'm across the artery there. It is smaller more distally. Okay, I'll take scissors.

00:35:48

JOHN PENNOCK, MD: So Chris, the right mammary has been taken down.

00:35:53

CHRIS MCCARTY, MD: I'm going to have to – I'm sorry, I have to switch instruments. I need to take my DeBakey in my left and my scissors in my left – yes, in my right. The reason I'm doing that, John, is because obviously I need to bring this IMA across the mediastinum to the upper port and I have to have the instruments in the right place.

00:36:24

JOHN PENNOCK, MD: Correct.

00:36:26

CHRIS MCCARTY, MD: So we have this right IMA clipped distally and I'm going to come across it. Clearly that blood was coming from inside this artery. Now we're going to take this back.

00:37:07

JOHN PENNOCK, MD: We're looking at the right internal mammary artery free.

00:37:10

CHRIS MCCARTY, MD: Free. Completely free. I'm advancing it back to my port access here of my – yup. Now Aaron is going to grab this with the CardioVations instrument. These are longer instruments. There it goes. It is a free graft at this point. Now I will be able to come and take this left IMA that is sitting right there. But before I do that, I'll check the hemostasis of both stumps again. Oh yes please.

00:38:08

JOHN PENNOCK, MD: Just take it out so we can take a look at it. White towel.

00:38:24

CHRIS MCCARTY, MD: So, you can see how far in we were into the chest. When you think about it, here is the left IMA, okay. We're coming under the sternum which is probably around here, got the mediastinum, and this is the vein. You can see the proximal stump is occluded and clipped and dry. The bed here is all dry which is all very important to make sure of and you can see that this distal stump is also dry. So I feel pretty comfortable to come back over to the left side and take the left IMA down. This is really the more standard technique is to just take a left-sided artery down. It's not super common to take both IMAs down but I'm sure it will become more so as people become more familiar and confident with their skills.

00:39:31

JOHN PENNOCK, MD: Now, this time you're going to leave the [unintelligible] attached.

00:39:36

CHRIS MCCARTY, MD: This is correct.

00:39:38

JOHN PENNOCK, MD: This is not a free graft.

00:39:39

CHRIS MCCARTY, MD: No, it is not.

00:39:45

JOHN PENNOCK, MD: But basically the same procedure to take it down.

00:39:49

CHRIS MCCARTY, MD: Correct. When you see that motion of me stopping it's because I'm rearranging my instrument arms. Up here I sometimes will – you have this nice bar to kind of keep your arms from floating too much and sometimes as the activity goes on, they can end up in places you don't necessarily need them and you

can't get the motion you need to out of the instrument arms, so you need to reposition, and there's a nice feature here where it will stop everything, stop the movement of your instrument arms, but allow your hands to be placed appropriately so that you can do what you need to inside the chest. So, again just cutting into that pleural surface so that you've got something to grasp onto as you're dissecting out your left IMA. Here's the – this is the part that was a little bit more tricky and difficult to learn because obviously taking down the right IMA I was taking it down just like you would through an open incision, medially to laterally. But here you're taking the IMA down laterally to medially, which is a little bit different and it takes a little getting used to.

00:41:41

JOHN PENNOCK, MD: I can see the blue veins and the white area next to it is the mammary.

00:41:51

CHRIS MCCARTY, MD: Yeah, sometimes it's kind of difficult to get into that plane, but there it is. I think everybody has their religion as to how they take the IMA down, whether you start proximally or whether you start in the mid portion, or whether you start distally. I don't think it matters much any which way you do it, just as long as you don't injure the artery. Here we have a pretty significant branch and you'll see it here and the bigger branches I prefer to clip because I never know what the thermal injury will be to the IMA. So I think it's a better idea to clip them and then to cut the branch. One more please. And I'll take the scissors. I'm not quite so concerned with the distal aspect of it, because I can cauterize that once I've got the IMA away from the chest wall. Okay, I'm sorry. So here we've clipped the major branch and I'll be able to start cauterizing the IMA away from the chest wall at this point. So I'd like the spatula back. Really what you want to see when you're taking down a free right or a free IMA is that you continue to have this pearly appearance to the artery. In other words, you want it to be nice and white and not have a lot of either blood on the outside or being very blue on the inside, which would indicate that you've got problems with the artery. A dissection in the artery itself, which would make it unusable as a bypass graft and you don't want to have difficulties in doing that because this is really a – The left IMA really needs to be revered in some ways. I don't know how else to say it. It is truly a survival benefit to the patient to have a left IMA to the left anterior descending artery and no other arterial conduit will replicate those results that we know of as surgeons and the cardiology community also knows that. So you really have to be very careful in how you treat it. It means everything to the patient.

00:45:41

JOHN PENNOCK, MD: So we're now getting ready to separate the left internal mammary artery distally. We're going to leave it attached proximally to the subclavian artery. We've heparinized the patient before we do this because we don't want any clots to form in the graft. Dr. McCarty, where are we now?

00:46:08

CHRIS MCCARTY, MD: We're exactly what you said. We have detached the whole left IMA from the chest wall and I am clipping it distally, and put one more clip and then I'll pan across to show you what has been done.

00:46:28

JOHN PENNOCK, MD: Why do we heparinize now?

00:46:32

CHRIS MCCARTY, MD: Just for like you said, so that we don't get clot in the graft, and then we also don't want to be having clots as we're doing the anastomoses, so that's why. As you can see, these clips are across the IMA distally, so now we're going to – if you could put the needle driver in my left, another needle driver in my

left. And Aaron, don't take out the right one yet, okay? What I'd like to show you, as you can see, we really have the full length of the IMA and how nicely it just kind of drapes across the patient and so there should be no tension as you go to try to do an anastomosis right in this area, as you can imagine. You've got a lot of length there. I'm not trying to make you guys dizzy or anything, but okay. Now we're going to pass a bulldog so that I can temporarily clip the IMA so that we have bloodless technique. Okay. The bulldog is a little temporary clip if you want to think of it that way.

00:48:23

JOHN PENNOCK, MD: She'll retrieve that when she does the thoracotomy and we're going to try another one now.

00:48:29

CHRIS MCCARTY, MD: Actually, I'm trying. There we go.

00:48:34

JOHN PENNOCK, MD: Here we go.

00:48:44

CHRIS MCCARTY, MD: Almost but not close enough, huh? I can't get it. If you put instrument arm in there, Aaron, for me. That's the reason why we put the string on those things, because we should be able to retrieve them. Even if we can't retrieve it now, just like Dr. Pennock said, we will retrieve it at the time of the thoracotomy.

00:49:26

JOHN PENNOCK, MD: There we go. Some nice hand-eye coordination going on right now to get this clip in the right position.

00:50:03

CHRIS MCCARTY, MD: Again, you've got to be cognizant of where the heart is the whole time. You can't go willy-nilly with these instrument arms. You've got to be cognizant. Now the bulldog also helps to keep orientation of your IMA, because as you can see, as a completely free graft, you could easily twist this. Okay, now let's try to get a U-clip in. A U-clip is a nice little [unintelligible] device. It replaces a suture as we have it and it allows me to do things a little bit more easily robotically. Could I please have the U-clip? Okay. Now if you could get me the other needle holder I would appreciate it.

00:51:22

JOHN PENNOCK, MD: What are we doing now, Chris?

00:51:25

CHRIS MCCARTY, MD: Now I am going to secure – what I need to do obviously is because we're converting from the robotic portion to the open portion of this procedure, I need to secure the IMA to the pericardium of the heart, so I have to take a suture and bring it here, and this is what this is. It's a U-clip and it's a metallic suture, if you want to think of it that way. It is nitinol. Okay. Now, I will take the scissors in the left.

00:52:23

JOHN PENNOCK, MD: Chris, how'd you learn to do that suture placement?

00:52:26

CHRIS MCCARTY, MD: Just hit or miss really. If you try to do this with prolene, you can well imagine it's a lot of a headache to try to do that. Okay. Can I have the -- ? Yup. Now my stump is bleeding a little bit. You know what? Can I have another clip there? No. I will tack this down to the pericardium and then I will be able to take care of that bleeding, because it's not very harsh bleeding. Okay.

00:53:40

JOHN PENNOCK, MD: That's just to keep it oriented.

00:53:50

CHRIS MCCARTY, MD: Keep it tacked down. Yes. Yup. And you can see, you have plenty of length there. Okay, and that's it. Now we can stop rolling.

00:54:14

JOHN PENNOCK, MD: Chris, can you review? We have a question. Can you review who are the best candidates for this type of procedure?

00:54:22

CHRIS MCCARTY, MD: The best candidates are people who have left-sided lesions. So, people who have circumflex and left anterior descending disease, or people who might have a very stentable right corner artery and stenosis in the left anterior descending, those would be people who are good candidates for this procedure. Or, even if you've got triple vessel disease and you think you've got a right corner artery that's ultimately stentable, that's another reason for potentially doing this type of a procedure.

00:55:04

JOHN PENNOCK, MD: That's getting into the newer concept of hybrid revascularization where the cardiologist manages one or two vessels and the surgeon manages the others.

00:55:18

CHRIS MCCARTY, MD: And as you'd know too, there are lots of vessels that we don't successfully bypass because they are too small but yet they may be very stentable vessels, you know? So, in that kind of a circumstance, it may be a perfect and ideal revascularization for the patient to have a combination procedure or a hybrid. But those will need to be done when the days – and they're coming. I think almost everybody is starting to get hybrid labs at this point which means that it's an operating room and a catheterization lab all in the same place, so that it's just a one-stop shop. Okay. At this point, we're done. We've tacked the left IMA down to the pericardium and we're going to pull back the robot at this point. So, the people at the table who are Sara and Aaron are going to be pulling that back. So, at this point, we've got everything we need for bypassing. We need to take this big instrument out obviously so it can't be in our way, as we are doing the anastomoses. We'll soon be set to open up that middle port, or the camera port, and extend it a little bit so that we can do the anastomoses that we need to. One will be to a large diagonal, which I showed you earlier, and the other one will hopefully be to the circumflex which is even further down on the heart. Now, Deb is going to pull the whole instrument back. This is called the patient side cart and that's going to be pulled back entirely. Aaron, I don't know if you can move over, but basically what you have as incisional sites here are three and they're still very small. The only one that's going to get enlarged is the one where the camera was right below the nipple, but you have to smaller ones that were serving as my right and left hands, and those will not be enlarged at all. We'll actually use the lower one to put our drainage catheter into and so we'll only be left with one other small incision up by the shoulder. So, what they're going to start doing now is setting up for the minimally invasive part, the small thoracotomy portion, and I'm going to go out and scrub, put my loops on and get ready. Okay?

00:58:06

JOHN PENNOCK, MD: We are now entering the second part of the surgery where Dr. McCarty's going to open the left chest through a small incision, maybe three inches in length, between two ribs. What interspace are you in there, Dr. McCarty?

00:58:28

CHRIS MCCARTY, MD: The fourth interspace.

00:58:29

JOHN PENNOCK, MD: The fourth interspace, between the third and fourth ribs. Get access to the anterior lateral surface of the left ventricle to find the vessels that she wants to bypass.

00:58:54

CHRIS MCCARTY, MD: It's good. So right now, all I'm doing is trying to get into the space that I was working in with the robot, but obviously a larger incision so that we can do the bypass grafting that we need to. I don't know. That's the problem, you know? Operating in a space that basically only myself and Aaron have view on.

That's the difficulty with this. I can't keep that though. You know that.

00:59:40

JOHN PENNOCK, MD: Well, once the anastomoses are done, we can show them the end result.

00:59:44

CHRIS MCCARTY, MD: Yeah. Okay. Thankfully technology keeps working with us, so we have this nice little retractor and it fits very nicely into a small incision like this and also helps to stabilize the heart by putting another arm onto this long arm here, which is really very nice. What I need to do now is open up the pericardium a little bit more and take a look around.

01:00:24

JOHN PENNOCK, MD: Okay, Chris. Where are we now?

01:00:25

CHRIS MCCARTY, MD: Okay, what we've done is we've made our incision, which is probably all of a two-inch incision. I then went about opening up the pericardium a little bit more so that I could identify my target arteries. I found both of them. They both look like they're bypassable. So what we're doing now is making sure that we have all of the arteries, meaning the left IMA and the right IMA ready so I can do a T-graft of the right IMA off of the left IMA. So remember we took out the right IMA through the port access? Well here it is. The purple mark is really just to keep the orientation of the artery for me. It really means nothing more than that. So I mark it so that I know exactly how it's oriented, so when it lies on the heart, I'm putting it in a reasonable direction without any twists in it so the blood flow is good. The left IMA, if you remember, was tacked to the pericardium. I now have it lying up here to perform the T-anastomosis. I'd like to have it right here. What I'm going to do is I'm going to let the bulldog off. As you can see, it has good blood flow. So I think we're ready to get started here. So we use very fine suture. I don't know if you can get any idea, but this is the size of the sutures. It's an 8-0 suture. It's extremely thin but it's very good for doing an artery-to-artery bypass. Can you see it across my fingers? Okay. Very thin. The best way to do this I think is to start at my corner. Yeah.

01:02:47

JOHN PENNOCK, MD: Chris, is it difficult to switch back from da Vinci to standard surgery?

01:02:53

CHRIS MCCARTY, MD: Yeah, it is. Yeah, it is. I'll tell you. I can sit here and say it all I want. I have very steady hands, but because of all the pinching action that you do with the robot, you lose that fine dexterity. Now thankfully you're able to hold your hand still on the instrument so that there's no problem for the patient.

01:03:54

JOHN PENNOCK, MD: What you're seeing is the left internal mammary artery, between the two green clips. The blood flow that goes down that artery rises from the takeoff of the mammary artery from the left subclavian artery, high up in the chest. The free graft that she's attaching to it will – one end is going to be sewn to the left internal mammary artery. The other end is going to be sewn to the

circumflex vessel that needs bypass. So that when she's finished, she's going to have what's called a T-graft, and [unintelligible] anastomosis, so the blood will go down both arteries, and the left internal mammary artery will be anastomosed to the large diagonal that needs grafting, and the "T" part of the graft, which is the right internal mammary artery, will be sewn to the circumflex vessel. When she's all done, she'll point out to you and show you that it looks like a "T", the shape of a "T". Dr. McCarty is now preparing to anastomose the internal mammary artery to the circumflex vessel, which is the first vessel she's going to bypass. Chris, do you want to explain your setup there?

01:05:39

CHRIS MCCARTY, MD: Yeah. So again, to reiterate, the thing that allows us to operate through this real small incision is that we use the da Vinci robot to take down the IMAs as far as, one, the right IMA is a free graft, which is now a T-graft to the left IMA, which is down in the chest at this point. This here is the right IMA and it's going to serve as the bypass conduit to the circumflex vessel. Here, we're doing this off-pump, using a stabilizing technique and I have the circumflex right in my view, right here. We're going to get ready to sew this and do the first anastomosis. This is the most difficult one. It's pretty far lateral on the heart, and with the good help of our anesthesiologist, he's able to maintain reasonable pressures and heart pressures that allow me to know that the patient's doing okay with all of this. Okay, now I need a medium clip. Hmm? You're occluded.

01:07:05

JOHN PENNOCK, MD: It's important to point out that the advantage to the patient of what's been done so far is the very small chest incisions. Post-operatively, this patient will have very little pain. He'll be able to breathe better than someone who's had their sternum split down the middle. That's a very important thing that you want your patient to be able to cough and deep breathe after chest surgery to help prevent pneumonia from forming and other complications. We're going to keep quiet now for about ten minutes so Chris can do this anastomosis.

01:08:09

CHRIS MCCARTY, MD: Well, we're back, and we did our anastomosis to the circumflex artery. Now we're going to use new technology that we were one of the first to use in the Northeast, called the "Spy" angiography system, intraoperative angiography system. What it is is it's a Canadian-based company by the name of Novadaq who thought of using a very old dye, that's fluorescein dye, that used to be used in Swan-Ganz catheters, it's used for ophthalmologic surgery. We give one cc of that and flush it with a ten cc normal saline bolus. We then use this camera. Can you bring it in, please? We bring this camera in and we're able to fluoresce the dye on a low-level laser camera. Okay, good. I think we've got it there. So the anesthesiologist, [unintelligible] Todd.

01:09:13

AARON MURSTOKA: Ready?

01:09:18

CHRIS MCCARTY, MD: Wait a second. The shutter's not up. Go ahead. There it goes. You can see how there was a whiteness to the artery – that's the right IMA – going to the circumflex artery, which is the white straight line underneath. Off. That tells me that the graft is patent, which is important when you're doing stuff through a small incision like this. None to nil. What's that? We'll do it on the diagonal, but I won't do it again here. Okay. You ready to come off of suction? Loosen up. Okay. Yeah, I think we can loosen up on some of these. Yup. Looks like it's coming from here, don't you?

01:11:14

AARON MURSTOKA: Well, I think it's coming from...

01:11:17

CHRIS MCCARTY, MD: Yeah. Okay. Okay. The ones that were most posterior, because now I need to be able to find that diagonal. Which is where?

01:11:55

JOHN PENNOCK, MD: So Chris, how you doing there?

01:11:58

CHRIS MCCARTY, MD: Well, we're done. Basically we finished putting the left IMA down to the diagonal, which remember has the 80 percent stenosis in it and this is what we're left with now. If you look at it, this here is the right IMA, coming off as a T-graft, and here is the left IMA, coming into that diagonal. The thing we're going to do next is do a Spy angiography shot of this to see how well it looks.

01:12:35

JOHN PENNOCK, MD: Dr. McCarty's now finished with the surgery and is closing the incision in the chest wall and, do you have any comments to make Dr. McCarty for what you did today?

01:12:48

CHRIS MCCARTY, MD: Well, hopefully it is a worthwhile procedure for the patient. I do believe that that is the biggest advantage here is what you're seeing right now, just a really small incision. From the standpoint for any surgeons who may be interested in this, it's really important to cover up the anastomosis with the pericardial fat overlying because some of the surgeons who have been doing this for a while robotically through minimally invasive operations notice that their first couple may have occluded because the grafts are right up against the pleural wall, because your graft is laying extrapericardial, versus your conventional bypass surgery where it's protected by the pericardium. So if you're going to be doing this surgery, you really need to protect your anastomosis, and I did cover that up. I don't think it's a thing that you could necessarily see. Obviously the closure is real nice and this guy is going to be left with a two-inch incision at the end which is really pretty astounding when you think about what we do normally. I don't know that you could really do this any other way, to do it in such a small incision way without the robot. You would absolutely need that as a big part of your procedure. I think that if you were try to do it directly, you're going to have to be left with a much larger thoracotomy incision to get better visualization of the IMA proximally, nor are you going to be able to get down the length of IMA that I was able to get down. So I think what we'll do is we'll have you come back in and see this when it's a closed product and see what your thoughts are.

01:14:50

JOHN PENNOCK, MD: You've just witnessed a two-vessel bypass, utilizing a robotic da Vinci device to assist in the operation and then the two bypasses performed through a minimally invasive incision, which measures about two and a half inches in length and we want to thank everybody for watching and listening and to have a good evening.

01:15:16

CHRIS MCCARTY, MD: Now, from my standpoint, if you look at this, you know, this patient had significant left-sided disease on his heart and, you know, still in the day of yore, he would have had a conventional procedure with a mid sternotomy and probably gotten one artery and one vein bypassed. Here he got total arterial bypassing through a two and a quarter – we just measured. It's two and a quarter inch incision. When you look at the final product and you know how he's going to do, I just can't see how this could be beaten, so thank you very much for coming and paying attention and sure hope that you learned something tonight.

01:16:15

