



## **Surgical Tutorial of a Robotic-Assisted Anterior Pelvic Exenteration**

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From Pennsylvania Hospital

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Good afternoon. I'm Dr. Tom Randall from the University of Pennsylvania Department of Obstetrics and Gynecology. And I'm a gynecologic oncologist at Pennsylvania Hospital in Philadelphia. My colleague, Dr. Daniel Eun and I this afternoon will be joining you to watch footage from an anterior pelvic exenteration performed with the robotic surgical system on a woman with recurrent cervical cancer developing after treatment with radiotherapy. Specifically, our patient today was a 48-year-old woman treated 20 years ago with radiotherapy outside of this country for locally invasive cervical cancer. She did very well, had no evidence of her cancer, as I say, for 20 years but in the summer of 2008 developed blood in her urine, or hematuria. She was found on evaluation here in the United States to have recurrence of her cervical cancer in the anterior portion of the cervix and the anterior vagina and it invading into the posterior bladder.

To make matters a little more complicated, she was one of Jehovah's Witnesses who accepts no transfusion of blood or blood products. Therefore, we had to be absolutely meticulous and be able to treat her surgically without any transfusions. Typically, what's performed in this clinical situation is a procedure called a pelvic exenteration. In this case, since the rectum is not involved, we would surgically remove the bladder, the anterior part of the vagina, the cervix and surrounding tissues as well last the uterus and both tubes and ovaries. In addition to that, we perform a quite extensive dissection of the lymph nodes in the pelvic area and lower para-aortic area extending up to the level of either the inferior mesenteric artery or the renal vessels.

In our patient we felt that, as she had small tumor and was a Jehovah's Witness who could not have a blood transfusion, we felt it would be very appropriate to proceed with a pelvic exenteration using the robotic system both to minimize the risk of complications due to the precision of the instrumentation and of our vision as well last our ability to minimize bleeding for the same reasons. Dr. Eun?

Hi, my name is Daniel Eun. I am an assistant professor at the University of Pennsylvania working out of Pennsylvania Hospital. I am building the minimally invasive and robotic urological oncology program there. In this case, to me, I felt that with her given history of prior pelvic radiation and being a Jehovah's Witness, just for background, in Jehovah's Witness patients, giving blood products is not an option. And so, if you have a patient who has had surgery and refuses blood products you would potentially have a patient who dies if they bleed down and you're not able to transfuse them. And so this is a really high stakes operation. We apply this fantastic new technology to this patient in hopes that we would be

able to do this operation not only safe from a cancer standpoint but also to do it safe due to our limitations and a prior radiation history. We hope that you guys enjoy our case that we're providing here for you today and thank you for tuning in with us.

Again, thank you for joining us. Let's go to the operation. We've got our patient now under general anesthesia, prepped and draped in low lithotomy position with the legs extended, ankle knee and opposite shoulder lines up carefully to avoid nerve injury with no pressure on the popliteal fossa. We like to measure out -- a lot of doctors do it by more informal measurements after they've done a lot of cases. We've been doing robotics here for about a year and a half, so we still like to measure out the port sites. We usually go about 25 to 35 centimeters above the pubic symphysis in the undistended abdomen. And this patient is quite small, relative to the average American. And so we're going to go at about 23 -- 24 centimeters. One thing we do here that's a little bit different is we go -- our first port is in the left upper quadrant just under the costal margin off the midclavicular line.

We go to about 25 centimeters. In this case, it's going to be about 23-1/2 centimeters and then in the smaller patient we're going in a straight line essentially across from that first port site. We're putting these about 8 centimeters apart, hoping that they'll expand a little bit as we distend the abdomen. We're going to use local anesthetic, in this case 1/2 percent Marcaine solution without epinephrine in the port sites for preemptive analgesia. And actually, usually I'll just put anesthesia in this one port site. I'll take a blade and then we use the Intuitive surgical smoke evacuator port for insufflation with this so that we don't need an additional port for air insufflation -- or carbon dioxide insufflation, of course, I mean. May I have a Raytech, please?

We'll hold up the abdominal wall. The stomach has been drained with a nasogastric tube. We'll place this into the abdominal cavity with a blunt trochar and insufflate with gas. Gas on, please. We see an appropriately low pressure of 3 millimeters of mercury, put the adaptor on. For most of our hysterectomies we do --

This is Dr. Randall. I have a question emailed in by a watcher, viewer from Rush University asking did we give the patient Procrit preoperatively to increase her hemoglobin and, if so, did we treat her for DVT prophylaxis. Of course, we treated her for DVT prophylaxis perioperatively. This patient did not require preoperative Procrit. She had a hemoglobin of 14.2 preoperatively. So we're very fortunate in that respect.

-- my assistant, Dr. Sara Adams, port site on the far side. And Sara, you can place that port. We'll up a 12-millimeter port under direct vision from the laproscope. We try to place the ports perfectly perpendicular through the abdominal wall so that they don't end up too close to each other within the peritoneal cavity. You note that we're using a 30 degree laproscope with the angle of the laproscope facing up to the abdominal wall. And using that, we can again see our work coming in under direct vision and pulling it to the peritoneal cavity a little bit, Sara. And we'll look and see her placement port to the thick black line on the metal trochar. We can now put the laproscope through the far right camera.

We're going to be using the Ethicons for these, remember.

We're going to replace that with a different port in just a minute. I'm going to go just to the right a little bit with this so that we try to avoid the fat from a falciform ligament. Looks like I didn't perfectly avoid it but it's an acceptable placement.

Going to bring up some audio here.

We'll close that.

If you notice, for our audience here, you can notice that Dr. Randall is placing his ports very high and I say that from a urologist perspective. It's a lot higher because our ports are normally placed around the level of the umbilicus. For this particular procedure it's important that he places these ports this high because this enables Dr. Randall and the robotic surgeon to be able to do a true para-aortic lymph node dissection, allowing him not only access to the lower pelvic lymph node dissections but to really come up to the level of inferior mesenteric artery and take all the lymph nodes from that point on and down distal.

And you're going to switch the laproscope so that it's looking down without turning the camera over. And there's the thick black line. Going to open this adapter, we're going to replace that port with a translucent port -- a minute -- through the same spot. Perfect. And how we're ready to dock the robot so that now we've got -- we're obeying the anatomy both of the patient and the robotic cart. We have five trocars in, including carbon dioxide insufflation in a straight line to abate the needs of the robotic cart and lower down than we would typically do to obey the anatomy of the patient.

And now we're ready, team, to back the robotic cart. So we see the uterus here, the tip of the foley bulb here, the round ligaments, the pelvic cul-de-sac. We see some radiation fibrosis, the mottled tissue from fibrosis. And that will become an issue during the course of the surgery, but so far, remarkably favorable anatomy for our procedure. Going to reflect this over and look briefly for any evidence of intraperitoneal disease. But I'm going to leave that for now because the next step is to check some para-aortic lymph nodes. And leaving the sigmoid colon adherent up to there makes our life a little easier on us, honestly.

We've cleared off the aorta up to the level of the renal vessels and the second and third parts of the duodenum. And just using instruments to open up this endo bag to store the lymph nodes in. And Sara is going to do a little bit of a water ballast there to keep that in the pelvis while we do our work.

Now that we're really ready to go, I'm going to clutch over to the number three arm. And this third arm is really invaluable with this para-aortic lymph node dissection in the way that it can hold the mesentery across and expose all of this for us. And my assistant, Dr Sara Adams, can hold up the mesentery and the duodenum like this. We have a nice view of the pre-cable fat pad here, the aorta from the bifurcation up beyond the level of the inferior mesenteric artery. Here's the IMA and it's originating from the aorta right here. And, of course we see the abdominal portion of the left ureter. One fortuitous part of this dissection for the para-aortic nodes is this tunnel that we create which later in the case will make it quite easy to bring the left ureter beneath the sigmoid mesentery to make our ilial conduit. So we see a peristalsis of the left ureter. We see the right ureter here all the way over here. Of course we're high enough up on our dissection that it will come back into the field. We've got to be careful that we keep track of the ureter all the way up as it comes back towards our field. And we're obviously clear -- with this patient's anatomy we're clear-

This is Dr. Randall again. I have a question which I think is probably good to review at this point in the tape. A viewer writes in and says, "Let's say hemorrhage occurs. Considering the patient's religious beliefs, what would be the proper procedure to follow?" I have a couple of answers to that. One is that I hope you see, watching the surgical footage, that we're able to take this a step at a time and go to great lengths because of what we can see and what we can do with the instrumentation to avoid hemorrhage. The second answer is that there's a great deal of hemorrhage that we can actually control with the robotic instruments. If one of the perforating vessels off the inferior vena cava is avulsed, we are

usually able to control that with a robotic instrument and have an assistant place a clip to control that. In a worst case scenario, we can move all the instruments away from vital structures and undock the robot and perform a traditional open surgery in a very small number of minutes. So we don't feel like this takes away our ability to perform a salvage procedure if catastrophic hemorrhage occurs.

I would like to echo that. With the safety of this procedure and this modality to operate, that you have a lot of control over your field. In addition to the ability to place clips quickly, I always have prolene sutures for vascular repair available in the room in the event that if I do have rapid bleeding that cannot be controlled with clips, I can usually hold pressure with a gauze pad or with a left-sided instrument. I'll ask the assistant to change my right arm to a needle driver, have them deliver a vascular repair suture and be able to quickly repair. But this is one of the strengths of the ability of the robot is to be able to suture rapidly and to repair this type of bleeding if the problem occurs.

We also have a second question here regarding, 'Would you use regular video assisted surgery for performing this procedure,' from Alexander Chartuni. My answer to this is I think you're referring to straightforward laproscopic surgery. It has been done at certain centers by very experienced laproscopic surgeons. This is a very difficult operation to do using straight laproscopic techniques. And this is one of the beauties of the robotic technique is it allows many surgeons to become very skilled laproscopic surgeon because of the robot's ability have wrested movements and filtered tremor.

-system for patients with previous radiotherapy that's an advantage is the better vision. And one knock on the robotics is the lack of tactile feedback, or haptic feel. However, I think with radiated patients, tactile feedback can lead you down the garden path. It can be misleading because the texture of the tissues has changed. So what you really need is with a radiated patient is to very carefully identify the structures by vision. You can't simply do things by feel as one can in the non-irradiated patient. And again, here we see a little perforator here. This one we were able to completely skip. Another perforator here we're take it nice and high where it goes into the fat pad. And this comes cleanly down. We end up with a very clean dissection. We're able to see the abdominal portion of the right ureter here and we proceed along.

One beauty of the wristed instruments in three dimensions, even without one pleasure of this is the stable camera, which any surgeon who's done a lot of laproscopy and have their assistants hold the camera will very much appreciate. But one thing we get from the wristed instruments is the ability, like we have with an open case, to constantly manipulate the tissue, double check the relationships of the structures. Certainly, you still need to have a pretty well developed structural visualization to do these cases, but you're able to check and double check relationships of these tissues in a way that might not otherwise be possible. This may be nodal tissue.

This is Dr. Randall again. I have a question from a viewer, Ken Wood, who says, "What are the two main instruments being used in the footage and what is the difference in procedure time, robotic versus open?" I should have mentioned in the introduction our procedure time was about 6-1/2 hours total procedure for the robotic portion with an additional hour and a half or so to complete the ilio-conduit at the end of the surgery. Open times can be shorter than this, but as Dr. Eun mentioned, I think, open procedures for this disease can have a lot more morbidity and particularly a lot more blood loss. So we felt that we had a good exchange of time for decreased morbidity and decreased bleeding in this procedure. What you see in the far left instrument in this current footage is something called a Cartier grasper. And what I also use in the second instrument from left to right is called a bipolar

fenestrated grasper. They're both very small instruments, about a centimeter in total length, which gives you some sense of the amount of magnification with which you're looking at this field. And the second one, the bipolar grasper, has bipolar current at about 50 watts. The right most instrument we call a monopolar scissors. It's a very sharp pair of scissors with an exposed portion about 6 or 7 millimeters long, with monopolar current on a coagulating type current, again at about 50 watts of current.

-the total tissue of the whole set -- this on the left side here. Sara, let's see if you can pull that just last loop there. That's right. We don't want to ask for too much. It's nice and clean. We'll carefully open up-

Dr. Randall, we've transitioned now to looking at the left pelvic side wall from the periaortic lymph nodes. We're in the early steps of the pelvic lymph node dissection for the procedure.

Just going back to what we were doing with this lymph node dissection, one of the criticisms of robotics has been that people say that you cannot do an extensive lymph node dissection using the robot. I think that we're showing here very clearly that you are able to do a very extensive and complete lymph node dissection and here are other centers also performing this and proving this where they are routinely able to harvest greater than 25 nodes on a regular basis. In this procedure, I remember us gathering about 42 lymph nodes in total.

Yes.

And urologists who we have watching probably are not as used to seeing this radiation fibrosis, being used to doing cystectomies and proctectomies in an un irradiated pelvis as a gynecologic oncologist do radical hysterectomies in the unirradiated pelvis. So here is a fairly foreign-looking pelvis -- fibrotic tissue and, of course, another issue is, as the audience knows, is that this is less forgiving tissue. This is tissue that doesn't have the same --

We have a viewer, Claudio Espinal asking, "What is the recovery time, post-op, for this procedure in comparison to a standard operative procedure?" by which I'm assuming, Claudio, you mean an open surgical technique through an incision. And it's hard to say. Typically patients having an exenteration will be in the hospital ten days or more to recover. Unfortunately, with these procedures they are very extensive, sometimes morbid procedures categorized typically by many complications. We've been very fortunate in the two patients we've treated at Penn by this procedure. Our patient here left after seven days in very good condition without a complication and a previous patient left after six days without a complication.

We also see now the genitofemoral nerve. So we've reflected the ureter the other way. We see a clean area along the common iliac vessel. And particularly in this more heavily radiated area, now we're out of scatter and into the direct exposure of the tissue to the radiation. We see that excellent vision is superior to tactile feedback again. Again, one advantage I have that's not as clear watching this is I can see those lymphatics and blood vessels lifting of the vessel with 3-D. Again I see the genitofemoral nerve right along here. Here we reach recreant circumflex iliac vein, which of course we use as the distal -- as a marker of the distal extent of our dissection. Again the wristing of the instrument allows me to put -- reach back towards the left side of the pelvis and put medial traction on these nodes. It doesn't make the coordination of it easier but it's an efficiency in that I'm able to use this left side of the instrument to perform a rightward task. I don't need to swap out the instrument to the other side like we would with traditional laparoscopy. And now we've identified the obturator nerve. We've identified the location of the ureter. Going to move

proximally along this internal iliac vein -- artery, excuse me, the superior vesicle artery. I'm going to center this into our surgical field. We're coming quite close to the bifurcation of the iliac vein. That's great, Sara, thank you.

This is a really good example of the strength of the robotics. If you watch how well Dr. Randall is dissecting in this area, harvesting the lymph nodes. As you can tell, he showed where the genitofemoral nerve is and you can see the obturator nerve down below, large iliac vessels just to the left of him. This is just a very dangerous area to operate. There's a convergence of a lot of very important structures that you can easily injure during this part of the operation. The ability for the robot to flex the wrist and to get around these corners, you can see that he's doing an excellent job of cleaning the lymph nodes out in a very meticulous fashion and it's being done safely here. And you know, again I say this to just reiterate why the robotic technology is so well suited to this type of operation.

Retracting our relationships is a luxury of the easily-movable wrested instruments.

We have a few more questions in from viewers over the Internet, one from Kristin Connelly, "What is the mortality rate of this procedure compared to the regular, non-robotic surgeries?" This is a procedure that has not been commonly done, particularly in a patient undergoing previous radiotherapy. We don't yet know what the mortality of his procedure is, honestly. For traditionally, for open pelvic exenteration, the mortality is, unfortunately, fairly high -- 3 to 5 percent is what we quote in the literature. Another viewer, Samir Sharma writes in, "What was the estimated blood loss with the robotic procedure and what is usual for an open case for anterior exenteration?" Our estimated blood loss for this procedure was 100 cc's. And even with extensive intravenous hydration with the procedure, her hemoglobin the first day after surgery was 11.8, which I think supports the idea that there was very, very limited bleeding or oozing with the procedure. Typical estimated blood loss for an open anterior pelvic exenteration would be variable and depend on the doctor you speak to and the series you read, but we're expect at least 500 to 1,000 cc's typically for those procedures. And similarly, another viewer writes, "While I understand the purpose of the para-aortic node dissection, what is the purpose of the pelvic lymph node dissection?" I think in this particular patient who did not undergo any previous surgeries -- she had radiotherapy alone -- we wanted to ensure that she had no regionally metastatic disease that might need adjuvant therapy after this operation.

The question with the mortality, in the urologic literature there is three recent series that were published, one by Khurshid Guru at Roswell Park Cancer Center, one by Raj Pruthi at Duke, and Prokar Daskupta, Dyes Hospital in London. They all report a mortality rate of approximately 1 percent using the robotic procedure

-unless I'm trying to take little tiny fibers like that. And that helps open up the exposure of the ureter there. Now we start to see better isolation of the ovarian vessels here. With the wristing of these instruments, I feel better equipped to truly isolate the vessels, the ovarians and uterines. And I think because of that, we end up with a safer surgery. Again, see how we're able to get order from the chaos of the post-radiotherapy adhesions. Range of motion of the instruments is so good that it's much easier to make sure getting exposure where I can see the ureter and the ovarian vessels at the same time.

Sorry, Raj Pruthi, if you're there listening. I meant North Carolina, Chapel Hill.

-the ureter here going down, the ovarian vessels here. You see the smoke clear as Sara's venting some of the smoke so she can either use the suction very gently evacuating smoke so we don't collapse the pneumoperitoneum. By the way, the pneumoperitoneum for this

portion of the surgery is at about 14 millimeters of mercury. Dr. Eun typically uses 18 or 20 millimeters of mercury pressure.

Just to clarify, I use 20 millimeters of mercury just for insufflation and accessing the ports initially, then I drop it to 15 or 12 millimeters for the duration of the case. That's my usual protocol, just to clarify.

And freeing up this pelvic peritoneum, pelvic cul-de-sac. De facto already free the ureter off the pelvic peritoneum somewhat. Sara, this is going to be easier, I guess, on this side. Can you reach that now, give you a bigger field of view. Just you can grab it with your-

I have two questions here. One is from Ludo Vorhoff. The question is, "What are your tricks to keeping the intestines out of the operational view for the higher part, doing the iliac and periaortic lymph node dissections of the operation obese women. It's very critical for this operation that we use proper patient positioning where we put the patient into steep trundelenberg. For the viewers who are not in the medical field, this means that we tilt the table to close to a 45-degree angle where their head is down so that when we insufflate the abdomen with air, a lot of the bowel contents will drop towards the chest, thereby allowing us to see and to be able to move lower down in the abdomen and the pelvis. In obese patients, patients with very redundant bowel, we can also use retraction techniques, especially from our assistant instrument or from our assistant that's sitting at bedside to help pull these things out of our view during that part of the dissection.

Our second question here is from Nick Panos in the UK. He's asking, "Is it safe to use monopolar scissors so close to the big vessels?" It is safe to use monopolar and bipolar energy close to large vessels. You just have to make sure obviously that you don't get into them. When you're doing the lymph node dissection, it's actually easier to be right on top, right on the vessels themselves instead of a few millimeters away because you enter into a plane where you're able to dissect and bluntly push the lymph node vessels. If you try to move a little bit away from the vessels, you end up having a harder time.

Significant fibrosis at this level, which makes sense from the gynecologic oncology, radiation oncology point of view, we're basically at point A here at the level of the distal ureter and the area of the maximum exposure of radiotherapy. Here I think we see the uterine vein quite clearly going beneath the ureter, uterine artery going above the ureter. The Maryland instrument can often be nice to have a more fine tip to put in between these areas. We might switch to that in a minute, although on the patient's right side it's certainly worked fine using the same instrument. Looks like the uterine vein right here. Looks like I got a little bit more. And there it goes. Little by little, we're freeing up the structures.

For the viewers out there, if you notice his dissection right now, he's really in the heart of the radiation fibrotic region where these issues are completely obliterated and socked in. And you can see the robot is a very, very strong instrument. And even with the full force of the robot, he's having a real hard time getting access into this plane and yet you can still see that he's managing to slowly and systematically gain access into these planes and to get around these vessels to safely cauterize and ligate them before moving on. It's just a tremendous job that Dr. Randall is doing here in this part of the dissection.

A Daniel Metzinger writes in, "Are you using a uterine manipulator during the procedure?" What we use in following the technique of Dr. John Boggess at University of North Carolina, we're using what's called an EEA sizer from colorectal surgery wrapped in a lapotomy pack, which is moist, so that we are able to push up the cervix and uterus, although not

very much in this irradiated patient with stiff issues. But we find that's simpler to place and doesn't have any risk of perforating the uterus, particularly in a difficult case like this.

-and Pam Sorano, our circulating nurse, just informed me that the frozen section on the para-aortic lymph nodes is negative, so we're in good shape to proceed with this excision. We're using a 30 degree scope facing down. At the moment, that's allowing me to see over the hill of the sigmoid colon and into the posterior pelvis. Then pretty soon what we can do is flip it over so I can look up at the rectovaginal septum from deep in the pelvis. What I can do in the meantime is to turn this camera a little bit so I can see around the corner. So I use angle of the scope without, frankly, flipping the scope. And now we move essentially trying to open up the posterior pelvic cul-de-sac here, which we feel is affected by radiation injury but not by cancer. Now we switch back to the zero degree scope, which is giving me the best combination of views into this rectovaginal septum and reach over the uplifted rectosigmoid colon. As most surgeons know, this area is often problematic, especially in a radiated patient.

Just as you heard Dr. Randal say a few seconds ago this is an area that's very problematic because he's dissecting right on top of the rectum. The issues, you see the yellow bit of fat that he was just pressing on. That's periodontal rectal fat. And he's pushing down on the rectal issues, especially in a radiated field, this area is really hazardous because it's very easy to make a perforation into the rectum and it could be potentially disastrous for the patient. And so you can see he's using very careful, systematic technique where he is very careful dissecting these tissues away. But this is probably for the robotic surgeon who's doing this procedure, one of the most stressful parts of the case.

I'm now going to look down in here. Hold that up to the right. That's the most perfect view in the world. But we can see pretty well that the rectum's down away from this uterosacral ligament. Useful part of the ureter is away. We're able better cauterize this uterosacral and free up our specimen posteriorly.

Okay now at this point in the procedure, we start a para-aortic lymph node dissection, freed up the lymph nodes, also created a window on the patient's left side beneath the rectosigmoid mesentery, through which Dr. Eun will be able to bring the transected left ureter proximal and bring it across the patient's right side for a urinary diversion. We've isolated the vaginal and uterine arteries and opened the recto-vaginal space posteriorly, taken down much of those pelvic side wall attachments within a centimeter of the muscular pelvic floor on either side. This is a small tumor. We're going to be performing a supralelevator exenteration anteriorly.

At this point I'm leaving Dr. Eun in the in the position of doing the anterior portion of the anterior extent, coming down in the pre-vesicle space and doing the cystectomy and connecting that cystectomy incision to where we've essentially done the half back/half of a radical hysterectomy.

Thank you, okay, so here we're going to go ahead and a take the ureters off here. And the reason why this is a good reason to have -- ago ahead, take it -- the white clip here is that I can handle the ureter without actually having to grab it. You're going to just give me one more? Normally in bladder cancer, we put a second wick down distally to prevent transitional cell carcinoma spillage. In this case it's probably not necessary but we'll just do it anyway to be safe ontologically.

I have two questions here. One is from an Alexander Chartuni from Brazil. How long does this take to set up all the robotic arms at the beginning of surgery? With a well-experienced

team it takes out 15 minutes to set up the robotic arms and to gain all the ports, to begin the case. There's also Carl Schwartz, who asked, "With all the trochar ports and the use of monopolar electricity, aren't you worried about capacitants coupling and direct contact coupling which lead to injury to areas other than where you are working. That is always a concern during laproscopic surgery, where we're using electronic energy. The robotic instruments and the laproscopic instruments are shielded so that we minimize that risk. We still have to be careful in our technique when we're applying energy because yes, you can spread an arc -- the energy to structures that you do not intend to. So that's something that we're always very careful about.

There's one other question here from Rush University Shamir Sharma, "Do you prefer the bipolar grasper over the gyros? I've used the PK dissector before. I think it's a fine instrument. I think it's dealer's choice what you want to use. I don't think that there's any distinct advantage of the gyros over the bipolar grasper. Thanks. Just a very judicious use of cautery here.

So just to catch up here, because they're answering the questions, to orient you, we're along the right pelvic sidewall. Dr. Eun has clipped and transected the right ureter and is now freeing it up from the right pelvic sidewall to mobilize it, to place into our urinary diversion.

The dissection of the ureter is very tricky because you have to try to dissect it off while minimizing your trauma and not interrupting the blood supply that's running alongside the ureter. We've disconnected the distal ureter and his lady's already been radiated in the past. So we're very, very concerned about the urethral blood supply and potential scarring in the future. We are very careful about trying not to apply any energy directly to this ureter. And we know that most likely at the end of the case, we're going to have to trim back this ureter a significant amount to transmission to get a an area where there's a viable supply. We also end up doing a Wallace type of urethro anastomosis back to the ilial loop so as to minimize our risk for stenosis, postoperatively.

Here's the soleus muscle and here's the hypogastric. And from here is going to come all of the pedicles, structures for our bladder. Now you can either take the pedicles by stapler or by clips. If it's very bulky and it's hard to see where your blood vessel structures are, then it's probably better to take a stapler across here. And here we can see them individually pretty well because this patient is very thin. Down here, we're down at the level end of all fascia already. So as you can tell here, it wouldn't be too difficult to take these with a clip and take these structures individually.

Just to clarify that statement I just made, when I said "bulky" I meant if there was a lot of fat, I know it's difficult to see. If it's bulky because you think that there is cancer in that pedicle it's not advisable to take a pedicle across there because you're going to increase your chances for a positive margin. And in that case, it's more -- it's preferable to take them individually, dissecting out the vessels and then clipping them. I think that you increase your chances of a positive margin if you draw a stapler down in the case where you had bulky disease in the pedicle.

This is a space right here that you can open up safely outside of the bladder and now off of the vascular structures. It will lock my fourth arm into place here. There's a difference in the instruments that we're using that it prefer to use. Again, it's very individual what surgeons prefer to use. I'm using a monopolar hook on the right hand. The left hand that's actively working right now is a Maryland bipolar and the alternate arm, which we call the fourth robotic arm, on the left is a new instrument that's recently been released by Intuitive and

that is the grasper. It's excellent and it's as a grasper but it's called a grasper because it also works as a great retractor. Once you start taking this at the peritoneal edge, usually you can find a fiber areolar plane between the fat planes we're able just come off. Well there's a plane that we'll divide here. What you really want to do is be able to get this plane right in front of the pubic bone. That's where it's avascular and you can do a lot of the dissection bluntly. As you can see right here, this fiber areolar plane, the body's telling us where to go. As long as you stay within this plane here, the dissection is bloodless. See this is a beautiful example of the human anatomy here. You can see the endopul fascia right here showing itself very nicely to us, okay. Okay, you want to come in here with a wick -- point up, point up.

Just to give credit where credit is due, my assistant here is Shawn White, who is a PGY 3 resident at the University of Pennsylvania in urology. Hi, Shawn. Okay, one down. Yep. Very good. Okay so this is our umbilical artery here.

I have a question from Raj Naik. Due to extensive diathermy, are the pathologists reasonably happy with the specimen? We got no complaints from the pathologists about this specimen. As you see, we are using a lot of electro cautery with this procedure. I'm sure you will agree we're being particularly vigilant with this procedure, due to our need to minimize blood loss. This patient, as I said before, had a very small tumor and so, even with extensive cautery in no way compromised the surgical margins or the status of the tumor on the final pathology review.

And in addition, if I could say one more thing about that, remember that the surgical footage we're looking at is highly magnified. We're using very tiny instruments at high current but usually very quickly. So actually the amount of cautery artifact we see within the surgical specimen is quite limited.

-- preview and the magnification, the resolution and the ability to see down here is just really amazing. Gee, it looks like there's a -- we've lost a little bit of audio so we've clipped across the superior vesicle artery. I'm approaching where I think is the inferior vesicle artery now just to give you an idea of perspective. And that is then the pulp fascia just beyond. To control this, specifically with clips, looks like it but as I keep going I don't see it. Okay it looks like maybe right here. We're very loud over here now. Okay, so I'm tempted here to now go ahead and take another clip. Okay, Shawn, you want to give me another clip here?

I have two questions here. One is from Nahad Ozgul: "What is the most common interop complication in this operation?" The most common complications that we would see would be bleeding, would be infection and with extensive lymph node dissection, lymphoceles. We can also have problems, postoperatively, that are often related to bowel and the delay of bowels to wake up, which we call illus. Ken Wood asks, "Typically, how many hours of training is needed to become a functional operating surgeon with the da Vinci?" I think that that's a difficult question to answer. I think that it's very difficult to put an hour number to this because it has to do not only with the amount of hours that you spend, but also how many -- the frequency of the operations that you're doing. Because the intensity of your experience is very important in that if two people spend 100 hours on the machine, if one person does a case every day versus one person does a case once every three weeks, there's a definite difference in the ability to grasp this technology and to use it well.

That's sad -- and not to interrupt the narration of the anatomy here, but typically we find that about 20 to 30 cases with the da Vinci, and as Dr. Eun says, preferably in a reasonably short time span are needed to get more comfortable with the technology. For an

experienced surgeon who's accomplished either at open radical surgery or with laproscopic radical surgery, the learning curve continues, I think, certainly up to about 100 cases anyway.

-- all this up here is going to be bloodless as far as the planes we're going through, this space of retzius. Here I can see with the structures of the medial and bocal ligament, the urethras are all here. It's just important that, as we go through these structures here, that you control the bleeding here well. As you can see, you don't need a clip here. You can just go through with copious amount of monopolar cautery and the bleeding will stop. Again, the structures here, the 12 o'clock above the urethra-

So here we've completed the space of retzius, which means the space that's anterior to the bladder. We have pulled the bladder off of the anterior abdominal wall and off of the pubic bone, the pubic symphysis. And now we have approached the point where the bladder is pretty much hanging on to the vaginal cuff. And we're approaching the final portion of our dissection here. Okay, superficial structure-

For the urologist, I can't speak for my gyn and oncology counterparts, but for the urologist this tends to be a little bit of a tricky portion of the case because you have to really find where the junction -- where the vaginal cuff is. And often we have a little bit of a hard time finding this because there's no real clear anatomical landmarks to find this. Sometimes the manipulation of the retractor in the vagina can help us locate this. But in this patient, it was a little bit hard to see exactly where the bladder ended and where the vagina started.

Shawn, you want to pull this over a little bit like this, just pull laterally over for us, yep. This is very dense here because of the previous radiation. You have entered into the endopal fascia. Yes, so visually you have to be able to sense how much pressure you're putting on the tissue. And I think that's really key in being able to move efficiently though these issues. You know, when you use cautery and you don't have enough traction on the tissues, the result is going to be ineffective trawling of the tissues. As you see here, for example here, if you put enough tracking here and you use the monopolar, the tissue will just separate out for you. If you don't have this amount of traction on here, you're not going to progress though the issues. And you're simply just going to leave a large amount of char. Okay, so this is our --

So one advantage we see here with this system is we are, Dr. Eun has entered into the lateral right fornix of the vagina. You can see the gauze that's covering the EDA sizer within the vagina. We're then able to see that move in and out and orient ourselves to very precisely remote any visible tumor that we can see as we progress along. In terms of getting tumor margins in a radical hysterectomy or radical cystectomy, we find that really offers an advantage, that we're able to see very precisely where we are.

I take this and grab this. A lot of this bleeding here is just kind of back bleeding from the bladder now, as we've already gone through all the blood supply that's supplying the bladder. As we're squeezing and pulling, we're squeezing some of the blood into the pelvis here.

And Dr. Eun and I know at this point in the procedure from the preoperative imaging and from our examination under anesthesia at the beginning of the procedure, that we are distal to the point of the patient's proximal bladder and vaginal tumor.

Okay, let's pull it down straight now. Do we have a catheter in?

At this point we are completely free except for the urethra. And as you can see, I asked that the catheter was in just to make sure that I have something filling the urethra so I know the moment I enter. But at this point we have just encircled the urethra and we're in the last portion of our dissection here. The remainder of the bladder and the uterus was completely free at this point.

So you got to use a combination of cautery and blood dissection because once you get down to the urethral fibers, it separates very well with a little bit of blunt action. Here again, you can see the urethra here physically, as my instrument is coming around it. And these are just the periurethral fibers. You can see right here as it wants to just separate out bluntly. And here we go. We have the urethra hanging in the breeze. So left ureter will be guide.

So here we've completely disconnected our specimen. I am simply tagging with a long suture and color coding the ureters and the terminal ileum so that we don't have to make a large incision after we deliver the specimen to perform the ileal loop. We can make a very tiny incision approximately two inches to deliver the ureters and the ileal loop up out of the abdomen so we can go ahead and create the urinary diversion. Okay what I'm doing here is I'm just tagging my ureters so that when I make a very little incision in the abdomen later on for the ileal loop, I'll be able to find them without any difficulty. What I'll do is I'll pull them out of the umbilical incision and that will really simplify matters so that I don't have to stick my hand in there and start fishing around for wet clips by feel. I'll color code all of them differently so that I'll know which one is what when I pull them up. Okay, scissor.

Samir Sharma is asking, "How many robotic cases had each one of you done prior to this case? Dr. Randall, how many robotic cases did you attempt a radical hysterectomy?" In my instance, I went to a very high-volume training center where I observed over 500 cases, observed or assisted. And I played in some part in consult-assistant in another 300 to 500 cases as well. Dr. Randall, you want to-

Dr. Sharma, I had performed about 150 cases robotically and certainly I guess a few thousand cases laproscopically, gynecologic oncology cases, prior to performing this surgery that we're watching today. I had a lot of experience with laproscopic surgery for endometrial cancer, some experience with laproscopic surgery for radical hysterectomy. And so actually adopted robotics for radical hysterectomy very early in my learning curve. I wouldn't honestly recommend that. I think probably it's wise to do 10 or 15 benign cases and 20 or 30 cases altogether before performing a radical hysterectomy robotically.

With the training that I have received, at this point I have converted almost all of major open urologic procedures to robotic technique. There are very few procedures in an uncomplicated patient that I wouldn't try to do robotically. At this point we do just about every robotic kidney procedure robotically including radical nephrectomies, partial nephrectomies, nephrouroectomies. We also obviously have done robotic cystectomies as well as prostatectomies and adrenalectomies. But just about everything in my experience has been able to be accomplished with very few exceptions.

I'd like to echo that for the gynecologic oncologists that in our practice at Pennsylvania Hospital certainly the vast majority of cancer operations we do now are with the robotic system. So the majority of the time that we would perform in open surgery would simply be because of bulky extra pelvic disease that requires a large incision to be removed. And I think also that I'd like to add I think that what you can see with this video is capabilities of the instrumentation and vision that gives you a greater comfort level as a surgeon and then what can be done with traditional laparoscopy. You see with the dexterity of Dr. Eun's motions that there's really very little, with a little bit of practice, there's very little given up

between an open surgical procedure with traditional instruments and this procedure, except that we're doing this with beer vision and without a large incision.

Here it is. So I'm going to take a little bit right here. You want to just cut this right here? Okay, the reason why-

So just as we're finishing up the video portion of this, I'd just like to give a big shout out to everybody at the University of Pennsylvania and Pennsylvania Hospital and give some recognition to some people. I'd like to thank my chairman, Alan Wein, for making this all possible. I'd like to thank David Lee, who's the Director of Robotics, at the University of Pennsylvania. I'd also like to thank Barb Villacheck, who's the Nursing Supervisor of the robotics program, as well as Pam Sorano, who is the RN in the room, Jeanette Roan, Allison Carr, who work as surgical techs in support of the robotics program. I'd like to thank Sara Adams, who is acting as Dr. Randall's assistant and is fellow for the year as well as the urology resident, Shawn White.

Okay, nice. Stay right there, stay right there. Okay take it, pull through. Nice, okay. And as you can tell here, we're going to have a lot of ureteral length here. We'll be able to trim some of the edges of the ureter that was devascularized a little bit during the distal dissection.

This is Dr. Randall back and we have -- Dr. Eun has tagged the ureters and brought the tags through the assistance port.

I'm now getting an absorbable suture to see the vaginal cuff. I've got it, thank you. As we look at this now we see Dr. Eun has completed the anterior portion of the anterior extent. We see the right pubic ramus, the symphysis, the left pubic ramus, the urethra arterially. And I like with this closure, I like to follow my stitch with my third arm, which allows me to keep tension on the suture. Just like we would do open, since I'm right handed I go from left to right so I'm not in my own way as I make progress. And oftentimes with the typical vaginal cuff that we've used cautery on, it's haemostatic by the end of the vaginotomy or pulpotomy incision. In this case, it's a little bit oozy and I'll do a locking suture, pull this through, lock it and it quickly becomes easy to pass this from my right hand to my left hand. I usually thread the suture through one side of the vagina at a time just to make it easier. Some of these cases we'll mobilize an elemental flap to bring down to the vaginal closure. I don't feel that's going to be necessary in this case. It feels -- seems that we've got an excellent blood supply in spite of the radiotherapy and extensive surgery. Throw a final stitch right across the apex right here. This is another situation where you don't get the feel, the haptic feedback, of tension on the suture, but pretty quickly you see the fibers of the suture well enough that, just like the dissection of the tissue that you see Dr. Eun do, you can -- your brain to some extent feels the dissection, feels the knot go down just because it gets used to seeing a stretch of the fibers of the suture.

Okay, now what we see, here's the rectum, rectovaginal septum. We've pulled up the posterior vagina and closed it to the shortened anterior vagina. The urethral opening is here and when we finish we'll just put a Foley catheter through this for a post-operative drain. See the pelvic nodal areas look pretty good. Our variant obdurate, or vein, we see the obdurate or vessels and nerve going through the atriary foramen. The other nodal areas appear haemostatic. We already saw the periaortic area when Dr. Eun was mobilizing the uterus. And again, here we see the uterus coming across the haemostatic periaortic nodal dissection area. So all appears to be in order. We're going to remove the robotic instruments and undock and finish the procedure through a mini laprotomy.

This remainder of the case is relatively bloodless, in that everything is well visualized. And did we get a final blood count, estimated blood loss here? About 100 cc's, very good. Thank you very much.

Thank you for joining us. You've just watched with us footage of a truly very extensive procedure done with a novel approach to surgery using robotic techniques. We hope you've seen, as we feel, that this new approach gives us an ability to do an incredibly extensive surgery with much lower morbidity than was previously possible. We're able to see things we couldn't see before and use delicate instruments to more anatomically and delicately dissect issues. Even to do a huge operation like this, we can do it in a way that's more easily tolerated by the patient. And not only that, but in addition to just showing you this one fairly obscure procedure that was quite extensive, we hope that this encourages you to join us doctors and patients to start a new revitalized dialog about how to perform surgery better, more extensively, more gently than we have in the past. You've seen footage of us removing lymph nodes from the lower aorta all the way down to the end of the pelvis, remove the uterus, tubes, ovaries, surrounding issues, the majority of the anterior vagina as well as the distal ureters or bladder, with a minimum of bleeding and no significant complications for this particular woman. And I don't want to overemphasize, I can't really overemphasize the fact that this particular patient, you understand, had a recurrence of cancer in her pelvis after being treated with radiation therapy. She had no other significant therapeutic options, other than this ultra radical surgery. We were able to do it in a woman who couldn't accept transfusion and and do it safely. And I think by meticulous approach, careful approach and fascinating and exciting new technology. Dr. Eun?

Thanks, Don. We really enjoyed bringing this particular case and shared this with this audience. We thank you for tuning in and joining us today. This is a very exciting time in surgery where we're able to merge fantastic technologies and to ultimately provide better surgery and better patient care and options to all of our patients. I echo what Dr. Randall just said to just urge other doctors and patients to continue to push to make medicine better and safer and less invasive. I think what you've seen today is a good example of how a very complex and sophisticated operation can be done safely and provide excellent outcomes to our patients. I think that what you've seen today is a little bit of what future surgery will be like across the board. I think that you will see more and more of these type of procedures being offered as more physicians get trained and as patients realize that these options are available. I think that most operations in our fields can be done using the robot. This patient, despite being on multiple days of IV fluids, never had a hemoglobin drop below 9.7, which is absolutely remarkable for this type of case. Whenever you do these type of operations minimally invasively, you always have to compare to the standard, which is open surgery, and to show that it is at least as efficacious and as oncologically safe. And the literature in urology that is being driven by the International Laudi -- cystectomy Consortium, headed by Guru Krishi Guru in Roswell Park Cancer Center, has merged a lot of data from multiple centers across the world. And they are showing that his is a safe procedure and that this is at least equal to the open oncological options for bladder cancer. Thank you, everyone.

Thank you all for joining us. I have one last note. This patient's final pathology report revealed a 3-centimeter tumor involving the posterior bladder, the vagina and the cervix completely removed, all 42 lymph nodes were negative for cancer. She was surgically cured with this procedure that you watched this afternoon. We want to thank our support, the administration and other doctors at the University of Pennsylvania, all our support staff at Pennsylvania Hospital. Thank you all for joining us. We look forward to talking to about this soon in person and online. Thank you.

Thanks.

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