

[MUSIC PLAYING]

**DAVID CHANG:** Hi. My name is David Chang. I'm a professor in plastic surgery at the University of Chicago Medicine.

Today, my topic is on current techniques and approaches to lymphedema surgery. I have nothing to disclose. Lymphedema is a debilitating problem. In the Western culture, highest incidence occurs in breast cancer patients following their treatment of lymphedema, such as removal of lymph nodes and radiation to axilla.

Up to 50,000 new cases are diagnosed annually. And up to 5 million Americans suffer from lymphedema. So what do we know about lymphatic system and lymphedema? Well, the lymphatic system mirrors a normal vascular system in that there are lymphatic capillaries that are located in the skin that drain to lymphatic vessels in the subcutaneous level, as well as in the deeper level. And eventually, they drain into the venous system.

It drains by contraction of the adjacent skeletal muscles, but there are also smooth muscle cells within the lymphatic vessel that contract, and this is a very, very important part of lymphatic drainage. Now this is a cross section of the lymphatic vessels. And what you can see is in normal patients, the lymphatic vessels look very much like other blood vessels in that there are three different layers with the smooth muscle cells within the media and the external layer.

This is a cross section of lymphatic vessel in a patient with lymphedema. As you can see, the lumen of the lymphatic vessel is occluded. Even within the remainder of the lymphatic vessel wall, those smooth muscle cells have atrophied and are no longer functioning.

So lymphedema often starts as a soft, pitting lymphedema, but in many patients it progresses to where the tissues become very firm and hard. And this interstitial fibrosis can be irreversible. And the smooth muscle cells within the lymphatic vessel walls atrophy, making the lymphatic vessels nonfunctional.

So what are current techniques and approaches to lymphedema surgery? This can be divided into two different types. One is excisional procedures and the second is physiologic procedures.

An example of excisional procedure is a Charles procedure where you, essentially, remove the skin and the fat down to the deep tissue, and then you skin graft the donor site. Another external procedure is liposuction. And you can get a very nice result with the liposuction.

The only problem is that the patient has to wear a decompression garment continuously for the remainder of life. As soon as the patient takes the garment off, within a day or two the lymphedema recurs.

Now the physiologic procedures involve microsurgical procedures. Here, we either try to reestablish the lymphatic function or bypass the area of lymphatic damage. So lymphovenous bypass is one of the such physiologic procedure that has gained a lot of popularity over the past decade or so. Here, we are trying to create a diversion of an obstructive lymphatic system into the open venous system so that the lymphatic fluid that's been backed up can escape into open system.

The first lymphovenous bypass was described in 1962 by Jacobson in a canine model. More recently, the types of lymphovenous bypass that we do involve what we call supermicrosurgery where very small lymphatic vessels are bypassed to a very small branch of the vein, less than a millimeter under the skin. The rationale being that the venous pressure at this level is very low, there's a minimal backflow into the lymphatic system.

I started doing this procedure in 2006 and these are the two studies that I've published since with the most recent being in November of last year where I looked at 100 consecutive patients. All the data was analyzed prospectively and we demonstrated that in these patients at 12 months there was 42% reduction in excess volume.

So another advance of lymphatic surgery has been the use of green fluorescent lymphangiography. What this does is it allows us to see the lymphatic vessels prior to even doing a surgery. It also sees the severity of lymphedema.

So on the left hand, that's the lymphatic system in a normal limb. You can see the lymphatic channels going up and down the arm. On the right side is a lymphatic system in a patient with lymphedema. There are some lymphatic vessels that you can see on the dorsum of the hand and the wrist.

But on the forearm, you can see a cluster of dilated capillaries. Those are dilated lymphatic vessels that is secondary to lymphedema. So by looking at these lymphatic vessels, I'm able to identify specific sites where the lymphatic vessels are, and then be able to do more specific bypasses under the microscope.

So this is an example of a lymphovenous bypass videotaped under the microscope. Now the entire surgery is done under the microscope, including the skin incision. And then we dissect down to the subdermal layer. Here, the clear lymphatic vessel has been identified.

Now I have to find a similar-sized vein near to do a bypass. And here, we just fast forward the video. And you can see the vein at the distal end. And there's the lymphatic.

And the background there, green background, there's a little grid. So each grid is 1 millimeter. So this is about 0.3 millimeter-sized vessels. And then I hand sew them together so that the lymphatic fluid can drain from the lymphatic system through that osmosis into the vein.

So how do I know these systems are open? And here, using the indocyanine green, after the anastomosis, you can see the indocyanine green dye going through that osmosis into the vein. And also, you can inject a blue dye and you can see blue dye go from the lymphatic system through the anastomosis into the vein so I know that the anastomosis is open and the flow is going from the lymphatic into the vein and not the other way around.

So what I found from my experience is that those patients with a minimal lymphedema, such as in first two pictures were they're intact lymphatic vessels with a minimal tissue fibrosis, these patients do relatively well with a lymphovenous bypass in that there was 61% mean volume reduction at 12 months. On the two right photos what you see are the examples of patients with severe lymphedema where there are minimal lymphatic vessels available with a severe dermal backflow. In these patients, lymphovenous bypass does not work as well. There was 17% mean reduction in volume differential at 12 months in patients with stage III and IV.

So this is an example of a patient with lymphedema. She had a mastectomy and radiation to her left breast and had lymphedema for five years. There is 32% excess volume of left arm over the right arm.

And this is her preoperative indocyanine green lymphangiography, demonstrating-- actually, you can see the lymphatic vessels going all the way up to the axilla [INAUDIBLE] bypasses ranging from 0.2 to 1 millimeter. And this is at 15 months. Left arm is now only 12.6% larger, which means a 60% reduction in volume differential.

Now vascularized lymph node transfer is another means of treating a lymphedema patient that has become more popular over the past 4 or 5 years. The first paper on a successful lymph node transfer was published in 1979 [INAUDIBLE] model. These are some of the examples of clinical papers that have been published mostly out of Asia and Europe.

Now there are two schools of thought as to how vascular lymph node transfers work. One is that the lymph nodes act as a suction device to suck the excess lymphatic fluid and then bypass it into the venous system. Second thought is that the transfer of vascular lymph nodes form lymphangiogenesis, reestablishing the lymphatic function at the site of the transfer.

And there is scientific evidence to support both mechanisms. It is very possible that both mechanisms work simultaneously. So there are a number of different places where you can take lymph nodes from.

The one area that I like to take is from the neck. It's called a supraclavicular lymph node transfer. The main advantage of taking the lymph node from the neck is that there is no risk of causing secondary lymph edema as you would if you took lymph nodes from the groin or the axilla. So you take the lymph nodes and the overlying fat in the skin from the neck.

And this is an example of a patient who had this procedure done. As you can see, she has a lymphedema of the left arm following the mastectomy and radiation. And the right side demonstrates the indocyanine green lymphangiography. She has, essentially, very little lymphatic vessels to bypass.

So for her, went into the axilla, opened up the scar tissues. We exposed the thoracodorsal vessels, which we will use as the recipient vessels. The tissue is harvested from her neck, transferred down to the axilla under the microscope. The artery and the veins are connected so that the lymph nodes that we transfer are living tissues. And a skin paddle is being used to monitor the flap.

And then this is the result. A year later, you can see the arm has had a significant improvement. It's almost a similar size as the normal arm.

Now a lot of my patients that I see present having had a mastectomy, radiation, no reconstruction, and lymphedema. So this patient has 49% larger right arm versus left arm. For a patient like this, the best option might be simultaneous breast reconstruction with vascular lymph node transfer. So in this scenario, what we do is use the abdominal tissue that we use to make a breast, and then take adjacent lymph nodes from the groin and do a simultaneous breast reconstruction, and we also provide a lymph node transfer into the axilla to treat the lymphedema.

One of the concerns with taking lymph nodes from a groin is, of course, creating a secondary lymphedema of the leg. What we do know is that most of the sentinel nodes, the nodes that are responsible for draining the leg, are located medial to the thigh. So when we are taking lymph nodes from the groin, it is important to stay away from the medial thigh, but to take the lymph nodes from the lateral portion of the groin.

Another thing that I do is I inject technetium in the OR prior to surgery and then using a gamma probe, identify the sentinel nodes that drain the leg and then stay away from these nodes that are responsible for draining the leg. So here's a little illustration demonstrating how this is done.

Abdominal tissue and the lymph nodes are harvested together. And then we transfer this to the chest and the deep system-- that's the system that supplies blood to the abdominal tissue-- is connected to the blood vessels and into the mammary vessels. And the lymph nodes are connected to the thoracodorsal vessels where the lymph nodes are placed in after the scars are removed.

So a closeup of the lymph nodes and the anastomosis of the deep system. So this is an example of abdominal flap with the lymph nodes. And you can see, there are deep vessels located-- that's the blood supply to the abdominal flap and there are lymph nodes isolated on the lower portion on the right photo. And this is an early result after reconstruction and lymph node transfer. At six months, her arm had gone down by 50% in volume differential.

Now sometimes, we have to do both breast reconstruction simultaneously, and this is how it would be done. In a similar fashion, but take the lymph nodes and the vessels from the same side and then transfer to the axilla to provide a blood supply to the abdominal tissue for the breast, as well as the lymph nodes for the axilla. Close up.

So this was a study that we presented last year at our annual meeting in plastic surgery where we had 24 consecutive patients. And on average, there was 47% reduction in the volume excess at 12 months.

So in summary, microsurgical treatment of lymphedema. Does it cure lymphedema? In most case, it does not. Does it improve severe lymphedema? In most cases, yes.

Does it reduce complication related to lymphedema, such as infections? In most cases, it does. And it certainly does improve quality of life in most patients.

But there are many things we don't understand about lymphatic system and lymphedema. There is a lot of research currently undergoing to better understand the lymphatic anatomy, physiology, and pathophysiology of lymphedema.

So this is a patient who came to see me after developing lymphedema following the surgery for gynecologic cancer. And we were able to resect excess tissue for her as a microsurgical option really was not an option for her. Nevertheless, following the surgery, she sent me this photo with a letter saying that it's my first hiking in 13 years, my first pair of jeans in 13 years and my first of sneakers in 14 years.

So lymphedema is a debilitating problem. And with microsurgical treatment or other type of treatment, we are able to significantly help improve the quality of life in many of our patients. Thank you.