



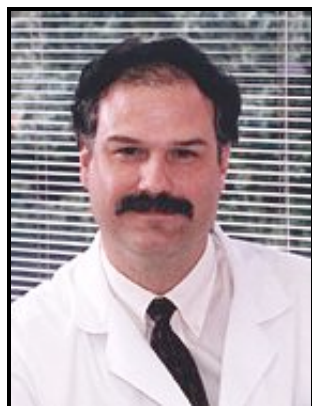
Online Slide/Audio Symposium



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Minimally Invasive Surgical Applications in Polycystic Kidney Disease



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Introductory remarks

What we are going to talk about today has a little bit more to do with surgical approaches, which is way off the end of the end of the spectrum that you just heard about. So if you are in a position where you have chronic pain, the drugs aren't working any more, can't do some basic day-to-day things, then you start talking along these lines.

00:00

Indications for minimally invasive surgery

- Not for acute episodes of pain
- Cysts tend to come back
 - 80% at best pain-free after 1 year
 - 60% after two years
- Everyone's treatment needs to be individualized

Indications for minimally invasive surgery

The acute episode of pain, popped cysts, bleeding into a cyst, the cyst infected and while it is infected it hurts, but when it gets treated it gets better--it gets drained, and the pain goes away. There are a lot of less than take-you-to-the-operating-room things that you can do for pain if the drugs don't seem to be working any more. And for the occasional patient, that is exactly what they need. For a lot of people, that is a little bit overboard. So just recognize the fact that this is not something you approach the day they say "ouch."

Cysts tend to recur; treatment sometimes only works temporarily

Also by the very nature of the condition and the fact that the cysts tend to come back, more so in the kidney, these procedures have never been shown to work over the long haul. Usually even the best of them work for only four out of five people over the first year. Actually one out of five of them have the pain come back over that time. And over the second year, which is about the longest follow up that people tend to be rigorous about reporting to you, another one fifth of them come back. So now 60 percent of people are still pain free. Everyone has examples, "I remember somebody--all we did was this, and 10 years later they were fine." And then everyone has bad examples like, "We didn't seem to be able to do anything to help that person." And so there is a spectrum involved.

Treatment must be individualized

Because it is so individual, not only how the pain affects you but also how bad it is, what has been done to get you over it up until now, and more importantly what is causing the pain--because as you will probably know from your physicians and previous meetings and talking to other folks here, cysts are not all the same. Not everybody has the same look to their kidneys. They all look cystic, but are they all the same? They are different sizes, different places. So everybody's treatment needs to be individualized.

Once you get out to this end of the spectrum, you are talking not about hundreds and hundreds or thousands of people who all need something done; it is not the same shoe-fit-

all. It is very tailored for those few who make it out to here. Since that is the case, it is difficult to ask questions about your own condition in this regard. So what I did was include some cases as we have done them and showed you where cysts are different. We will get to that, but before we can, I just want to show you this.

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CT scan of polycystic kidneys

This is a CT scan. You've seen a ton of these. I don't know how good everybody is at being a radiologist. I wasn't all that good when I started out. Just to give you an idea of all these films you've been shown... because you will see more. This is like a slice through the body, like a slice through bologna. Does that make sense? The feet are sticking out towards you, and the head is away. So the person is lying down, and you are standing at the foot of the bed.

That is why the right side is over here on the left and the left side is over there on the right. It's because the head is away from you. So just think of this as a slice through a person as you are standing at the foot of the bed looking at them lying down in your bedroom. Then it makes a little more sense. The slices can be taken anywhere-- up through the heart, down through the thighs. In this case, we took one in the area of the kidneys.

Appearance of the kidneys

This big lumpy, sort of going everywhere all-over-the-place structure is the right kidney. And this one, this big lumpy thing, is the bottom of the left kidney. Over here is all the space that is left for the colon and the intestine and all your guts and all the stuff that is supposed to be filling all that. That is a blood vessel. That is your aorta. It has a little bit of calcium in there. That person might have had a typical American diet.

Structures other than the kidneys visible on CT scan

And with time, you can get used to seeing some pretty interesting structures, like the layers of the abdominal wall, the individual muscles. It is a little blurry, but you can definitely point

out where there is lots of calcium, which is basically the spine. This is just x-ray. It is a CT scan, but it is just using x-rays. So things that are bright tend to either be blood vessels that have dye in them or bones. Things that are dark tend to either be air, like air in the lumen of the intestine, or fat, fat lining around the kidneys. That's a normal place to have it. This person doesn't have any pain at all, by the way. Totally free of pain. No problems.

00:00

Acute and Chronic Symptoms

<p>Acute</p> <ul style="list-style-type: none"> • Cyst Rupture • Cyst Bleeding • Infection • Renal Stones • Hematuria • Rib Fracture 	<p>Chronic</p> <ul style="list-style-type: none"> • Intermittent Acute Pain • Early Satiety • Lung Restriction • Pressure • Organ Dysfunction
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Causes of pain in PKD

Acute pain

So what causes pain? There are some acute things that can happen, an acute screaming "ouch", like a cyst pops or bleeds, or much more dangerously and thank God very rarely, it bleeds and then pops and keeps bleeding; infection; kidney stones; blood in the urine that can cause clots that stick in the ureter; or we have even had a patient who had such severe liver disease that when she bent over, she broke a rib. That is all acute pain, for which acute pain medication is reasonable.

Chronic pains

But then there are chronic pains. For instance, if you keep having these things happen over and over again or if you can't seem to get those infections cleared up, it can turn into chronic pain. There are also chronic problems that contribute to pain--fatigue, weight loss, being run down, not being able to breathe well, constant pressure sensation; then eventually as you get sicker with organ dysfunction, all that feeds in too.

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Basics of minimally invasive surgery

- Equivalent to laparoscopy
- Working through multiple small incisions instead of through one large incision
 - Post-operative recovery is faster with these small incisions, although the benefits may not appear for several days after the operation
- Uses advanced technology

Definition of minimally invasive surgery

So what we are going to talk about today has to do with how to approach that. The biggest thing I was asked to discuss was minimally invasive surgery. Minimally invasive surgery is sort of equivalent to laparoscopic surgery, basically. Instead of making a great big opening in your abdomen so the surgeon can reach his big mitts in there and work around inside of you, what they do is they put in a telescope through a small tube, inflate the area with some CO₂ gas and look around with an image projected on a TV screen. I will show you what that looks like.

Why do that? Well, if you don't have that big opening in your side, you feel a lot better after the operation. Do you feel that much better? Well, for a gall bladder, which turns out to be a very tiny operation that was done through a very, very big hole in a very sensitive place, right under your rib cage, it was a revolution. It went from an operation that made people feel rotten for a good four weeks to something that nowadays routinely go home the same day from. But for big operations like working on your kidneys or taking out a piece of your liver or taking out your kidneys, is that something that minimally invasive surgery really helps you with? Not on the first day. After about three or four days, you're feeling a lot better; whereas the other way, it maybe would have taken 10 or 20. Not on Day #1. People are still in the hospital. People still need pain medicine from the time of the surgery. They do get better. The big difference is recovery time and how much more quickly they can get back to the life that they have been missing. There are some improved technologies that we will go over.

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Pros and cons of MIS

Advantages (reduced systemic disturbance)

- Less intra-operative stimulation
- Less stress-hormone responses
- Less inflammatory mediators
- Less tissue damage
- (Less bleeding)

Potential problems

- Higher Carbon Dioxide
- Reduced Renal Blood Flow

Advantages of minimally minimally invasive surgery

Minimally invasive surgery does reduce what they call **systemic disturbance**, in other words that rotten feel you have after you've had a big operation is the same reason you have a rotten feel if you fell down and broke both of your legs or were hit by a truck because those kinds of injuries, and that is all surgery is--controlled injury and make you feel bad. The perioperative discomfort isn't that much different, but it goes away quicker. The post-operative comfort down the road when you are getting discharged is much less. Recovery time is faster. So we will go over this a little bit.

How is "systemic disturbance" reduced?

What is it that reduces the systemic disturbance?

- **Small incision** -- Well, you don't have that great big opening made into you. That in and of itself is hard to get somebody through. The anesthesiologists realize to crank the drugs in there to keep somebody asleep, comfortable, pain free, and more importantly not moving, when there is a big incision made in the abdomen. There are a whole series of stress responses that we all make when we are injured. That has been shown to be less during minimally invasive surgery.
- **Inflammation** -- that red swollen look when you bang your wrist? Well, that goes on in the area of the surgery, too. It is actually less when it is done minimally invasively.
- **Tissue damage and bleeding** -- There is less damage, less bleeding.

Potential problems with minimally invasive surgery

There are a few differences that are kind of important. If you have bad lungs, we inflate the abdomen with carbon dioxide. That will make your CO₂ rise in your bloodstream. And because you inflate the abdomen under pressure, it can actually decrease the amount of blood flow going to the kidneys, which is not a big deal if you are taking them out, say you have had a transplant and you need them out or you need one of them out. But if you want to keep them both and they are not working so good, you've got to be fairly careful with that.

Recent Technology

- Ultrasonic Shears
- Argon Beam
- Dexterity Port
- Laparoscopic Color Duplex
- Instrumentation
- Dedicated Suite

Recent technology

Most of the things that you do in surgery aren't so fancy. You cut through stuff and then you sew it back together. It sounds fancier than that, but it isn't. How do you cut through it if you can't get your hand in there with a pair of scissors or a knife?

- **Ultrasonic shears** -- Well, there are all kinds of indirect ways. People have heard of laser. That sounds really cool. Unfortunately laser of that high energy is a beam that goes on as far as you want it to. You could start it here and shine it off of a building in Chicago. Having that continue to go on through your body is not a good thing, and having collateral damage is something that is really a problem. There is an electronic scalpel that is used very frequently. It is named after the company that makes it, for some reason. It is called a Bovie. That is just like controlled lightening, and when it strikes it can tunnel down into other areas and damage other tissues, too.

There is a new one called the Harmonics scalpel, which is basically ultrasonic. I will show you a picture of that. It is essentially such high sound energy that screams the stuff apart that you are trying to cut through. It actually focuses all the energy just between the jaws of what you are grabbing, and it doesn't spread the damage to anywhere else.

So that is one recent piece of technology that is available and used in this procedure, and it is very important because if you are going to be working around somebody's blood vessels to their kidney or working around the kidney itself, you don't want collateral damage.

- **Argon beam** is a jet of argon gas that is ignited. It looks like a flame thrower, only it doesn't burn deeply. It burns very superficially. You all know that the cysts have lining and the lining is live, made of cells, and the cells are what make the fluid in the cysts. And you've got to do something to stop those cells from going back or re-

making the cyst. One thing you can do is just toast them.

- **Dexterity port** -- There is a thing called the dexterity port, which I will show you. It actually helps you get a hand up on the thing.
- **Laparoscopic color duplex**, a fancy way of saying it is a doppler. So it makes squishy noises when you hear blood going by. And it is an ultrasound machine, so it makes those fuzzy images that you can see on ultrasound. And it can put them together so you can superimpose the blood vessels on the fuzzy image. So it looks like a fuzzy image with blood vessels on it. And it comes in a system that you can shove through one of those little ports and not have to make a big hole in the abdomen to look at the liver or the kidneys with it. And that can be very helpful. I'll show you why.

The instruments are getting better and having a dedicated operating room suite is very important, too.

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Examples of minimally invasive surgery equipment

This is a little port. It is a little plastic item. It has an end on it that is about as thick across as your pinky nail. And it has a little camera going down it. This is actually an opening made here with a little sponge covering it up. There is a little piece of intestine poking out, saying "hi", just so you know there is really an opening there. It is not psycho-surgery. And then this is a fixed appliance that basically glues down temporarily during the operation.

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The surgeon can actually put his hand into a bag that seals the pressure in and then with time actually reach right down into the abdomen and see his own hand inside of you on the screen. They can't see what their fingertips are doing. But if he looks on the video screen, he can see what he is doing. That is one way to get a hand- assisted approach. The biggest limitation in laparoscopy surgery are you can't put your hand on it, you can't feel the pulse, you can't move it side to side. If you can't see behind something... you don't walk behind the TV set to see what is behind it. But in open surgery you can, and this adds that back.

Having the suite set up with all the instruments in the area, all the nurses trained, having the cameras and the television monitors suspended... and this was actually taken in Cincinnati, where I came from. In Portland, where I work now, the suite is even nicer. Even the anesthesiologist has his own camera built into his machine so he can see what is going on with you even from behind the curtain.

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Discomfort

Pros

- Minimal incision
- Less narcotics
- Less medication
- Nerve interruption
- Recovery

Cons

- "Nocebo" effect
- Extensive surgery
- Hospital stay
- Conversion to open
- Nausea

More on pros and cons of minimally invasive surgery

Discomfort

We said discomfort is better. The incision is less, the pain medicine is less, the recovery time is quicker. Sure. But there are cons, too.

Hyperesthesia

There is, in addition to hyperesthesia--and if anybody has had an infected joint or an acutely injured arm and just brushing air over the skin hurt--does that sound familiar to anyone? That is hyperesthesia. That is the kind of pain that people with polycystic kidney disease sometimes get in the areas of referred pain and postoperatively. That kind of pain is not pleasant, and it is real.

Placebo and nocebo effects

There is also a thing called a placebo effect. You think you are getting something, you take it, it makes you feel better, and then they surprise you and say, "I just gave you a sugar pill." You've heard of placebos. Placebos work because your brain turns out chemicals, because of your anticipation that they will work, that are actually true pain killers. There is also a thing called the nocebo effect. In other words, you don't expect it to get better and even though you do get real drugs, it doesn't get better. And that can happen. Some people suggest that the strongest version of that is nocebo death, which is what they say kills people when they think they have had a voodoo curse on them. I don't know if that is true or not.

It is still an extensive operation, requires a hospital stay. There is a chance of conversion to the open procedure. In other words, if something goes wrong and you can't fix it through those little tubes, you need to open things up enough to be able to fix it. Luckily, that incision tends to be much smaller than the ones that you would use for the old operation, but it is still possible. It has happened once in our new program.

And then nausea is a little more noticeable and probably a little more common because of

the abdominal stretch.

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Goals in Cyst Reduction Surgery

- Pain Relief
- Relief of Compressive Symptoms
- Preservation of Renal Function
- Reduction in Hypertension
- Thorough Examination/Staging

Goals of cyst reduction surgery

So the goals are to relieve the pain--that is why the person comes; getting rid of the compressive symptoms is also very important because a lot of times it is not only sharp pains in certain areas but a sense of dull, driving pressure that won't go away. You don't want the kidneys to work less well. You can, sometimes, impact upon hypertension. You want to get a good look at everything, better than what you can get just through the x-ray, just to make sure you are seeing everything you need to see.

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Preoperative Evaluation of Renal Cyst Disease

- Appropriate history and symptoms
- Standard urinalysis, serum chemistries and pre-anesthetic screen
- CNS screen if necessary
- 24 hour collection for creatinine clearance
- CT scan
 - Standard vs. CT angiogram
 - 3D reconstructions
- Nuclear medicine study

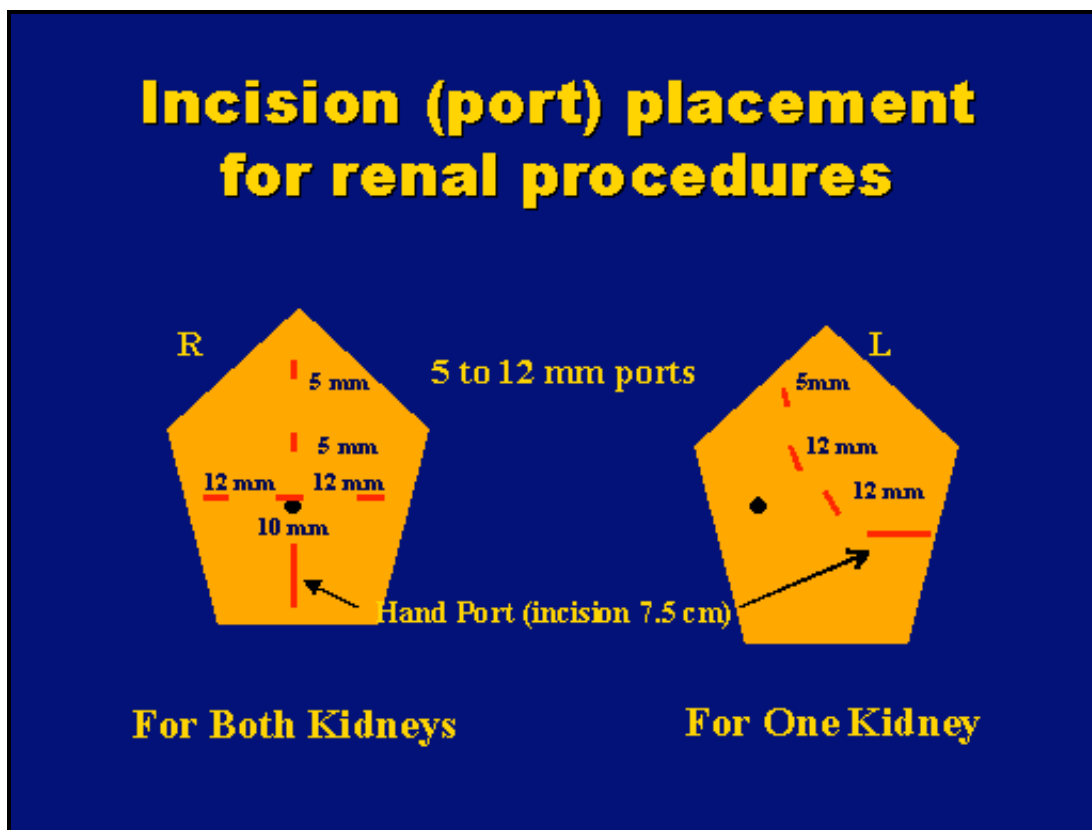
Preoperative evaluation

What do you need to go through to get an operation like this?

- **Appropriate indications** -- Well, apart from having the appropriate history, having chronic problems, this is a reasonable thing to do, your symptoms are things that can be fixed--they are due to the kidney problem or the liver problem as opposed to a back injury or something else, you have to be careful you are doing it for the right reason.
- There are a whole bunch of tests of kidney function and things that need to be done.
- You need to make sure the person does not have a high family incidence of any intracranial aneurysms because general anesthetic and a major operation can be a very big challenge to an aneurysm.
- Get a good idea of what your kidney function is.
- Then the CT scans, which I will show you;
- Sometimes a nuclear medicine study, and I will show you one of those, too.

Most of that is doable before the patient ever comes to see the surgeon.

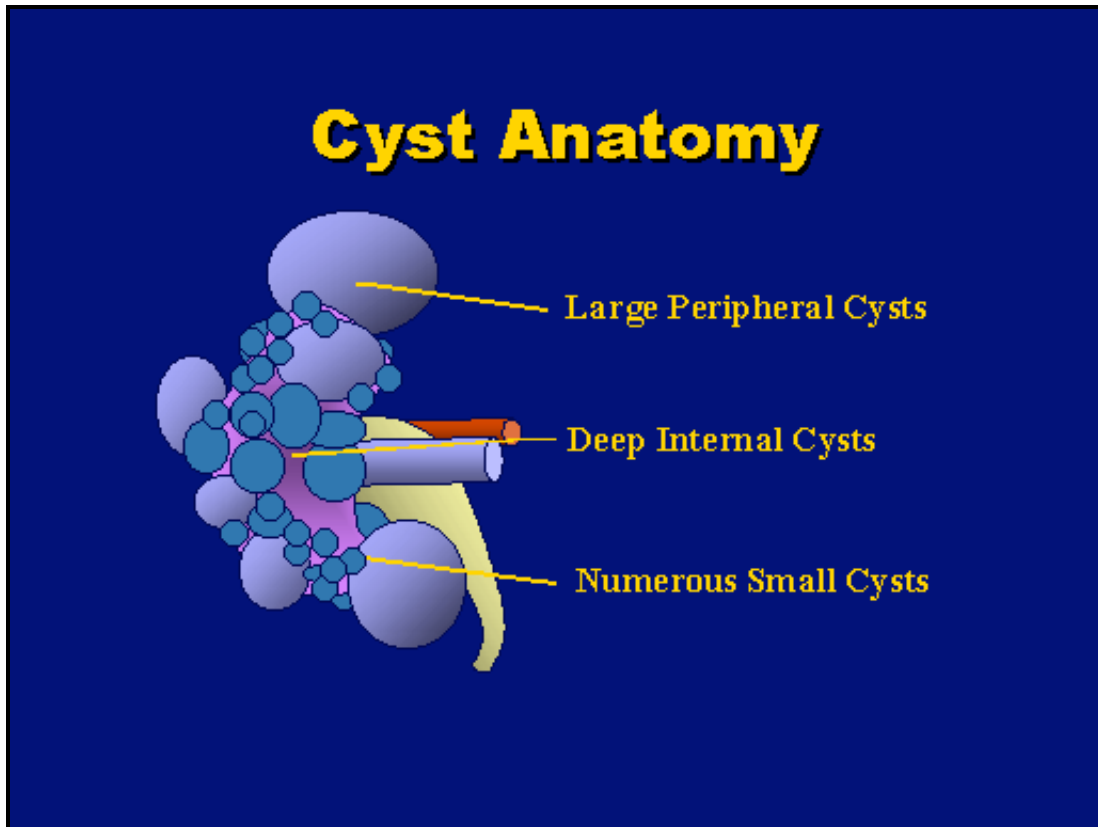
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Placement of abdominal incisions (ports) for operations on one or both kidneys

(Pentagons represent the abdominal wall with location of umbilicus shown as a black dot) Sometimes people need things done on both kidneys. Sometimes they only need things done on one kidney. If you are doing both kidneys, 12 mm or 1.2 cm, about 1/2 an inch, is the largest incision that is made unless you have to go ahead and put in the hand port, which is about the size exactly across as the size of my wrist or your wrist. Take a look at your wrist right where you wear your watch band, and that is about the longest incision that we make. That is where the hand goes in. If they are all lined up towards one side, then they are all aiming at the kidney on that side.

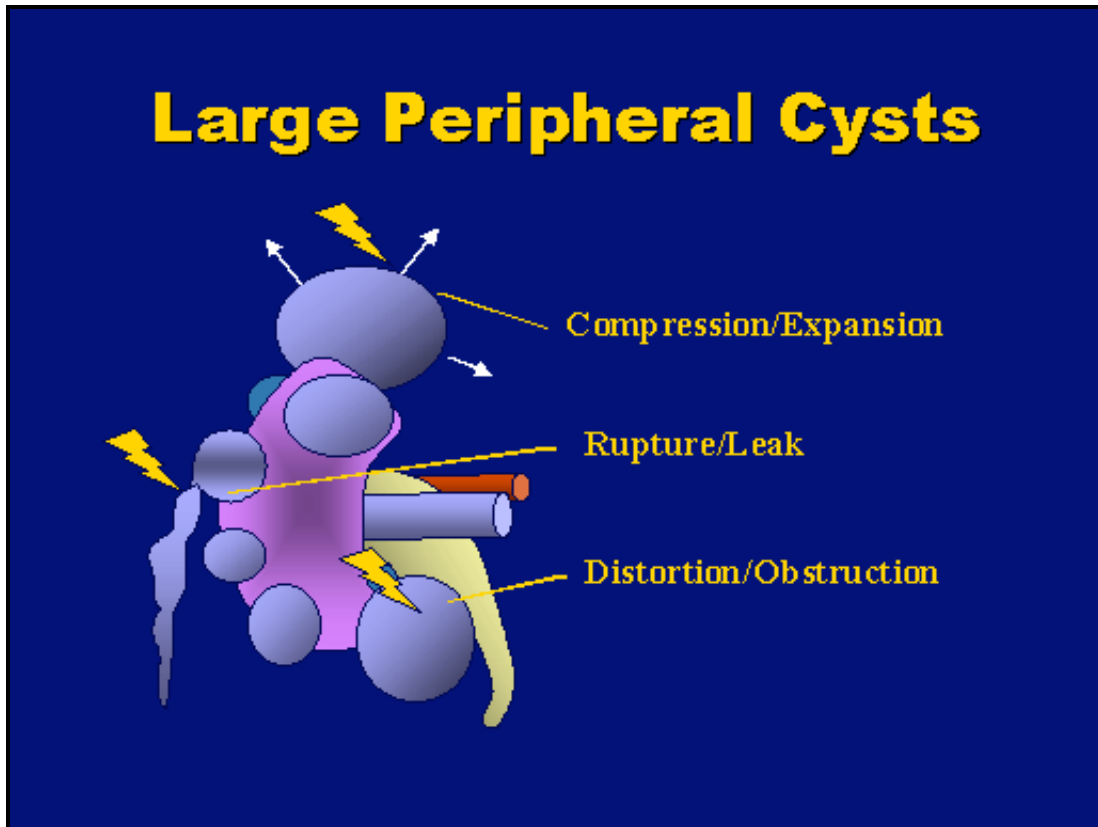
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Cyst anatomy

Then we want to know what is going on with the cysts. Once we get the kidney uncovered, we take a look at it. A lot of times, we'll see these get big cysts that bulge off and press on things. And sometimes they hurt. There are lots of deep cysts that you can't see. They are buried inside. And then when you've seen the pictures of them--notice how it doesn't seem to look normal at all. It is not like a normal kidney with a bunch of big cysts bulging off but there are lots of little cysts all over the place, too. Each of those may be more or less prominent and more or less responsible for the problem that the person is having.

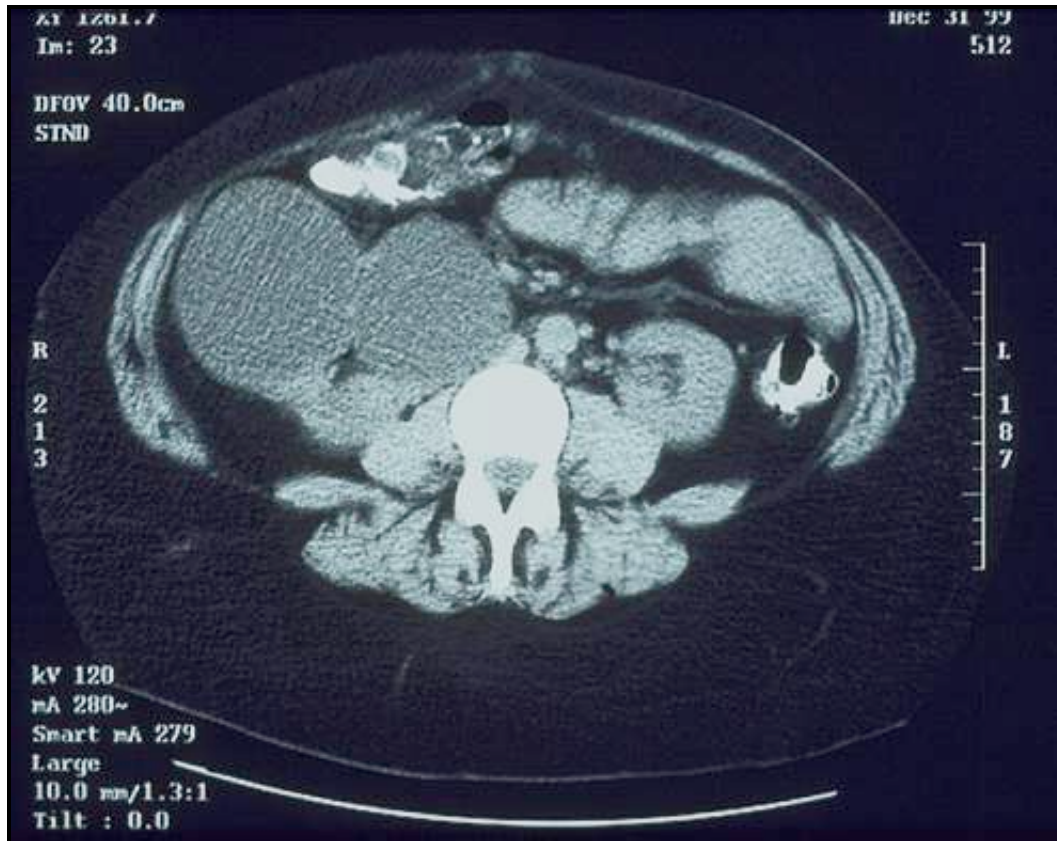
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Problems with large peripheral cysts

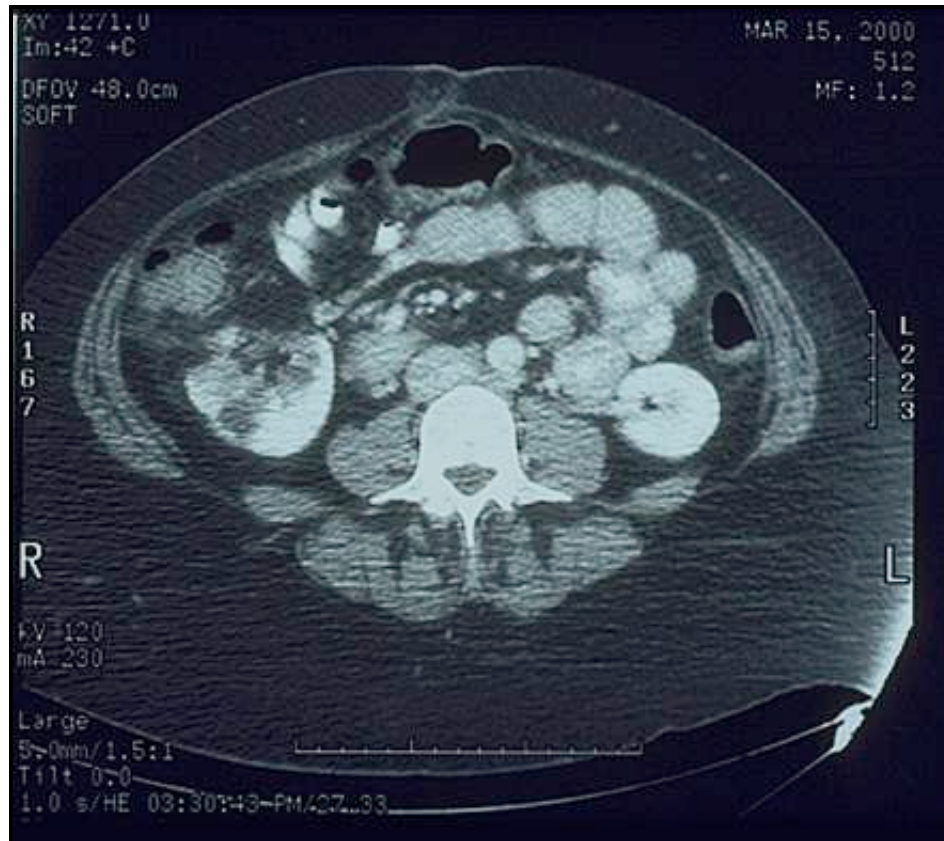
If you look at just large cysts, they press on things, they expand, they can rub against other stuff, then tend to pop and leak so you get a lot of pain there and also pain down there. That is acute. Distortion and obstruction of the ureter and back-up of urine in the kidney or damage to blood vessels is all possible. These big cysts can actually erode their way into blood vessels, which is why bleeding into them happens. So large cysts, especially ones that project out, are usually the ones that you hear about because those are the ones that are easiest to take care of.

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**Example of a patient with large peripheral cysts**

Here is a person who I told it looked like Mickey Mouse, two ears and then the kidney. These are cysts bulging off of the right kidney. Here is the bottom left... each kidney had their own cysts on (cuts up), but these are the big ones on the right side.

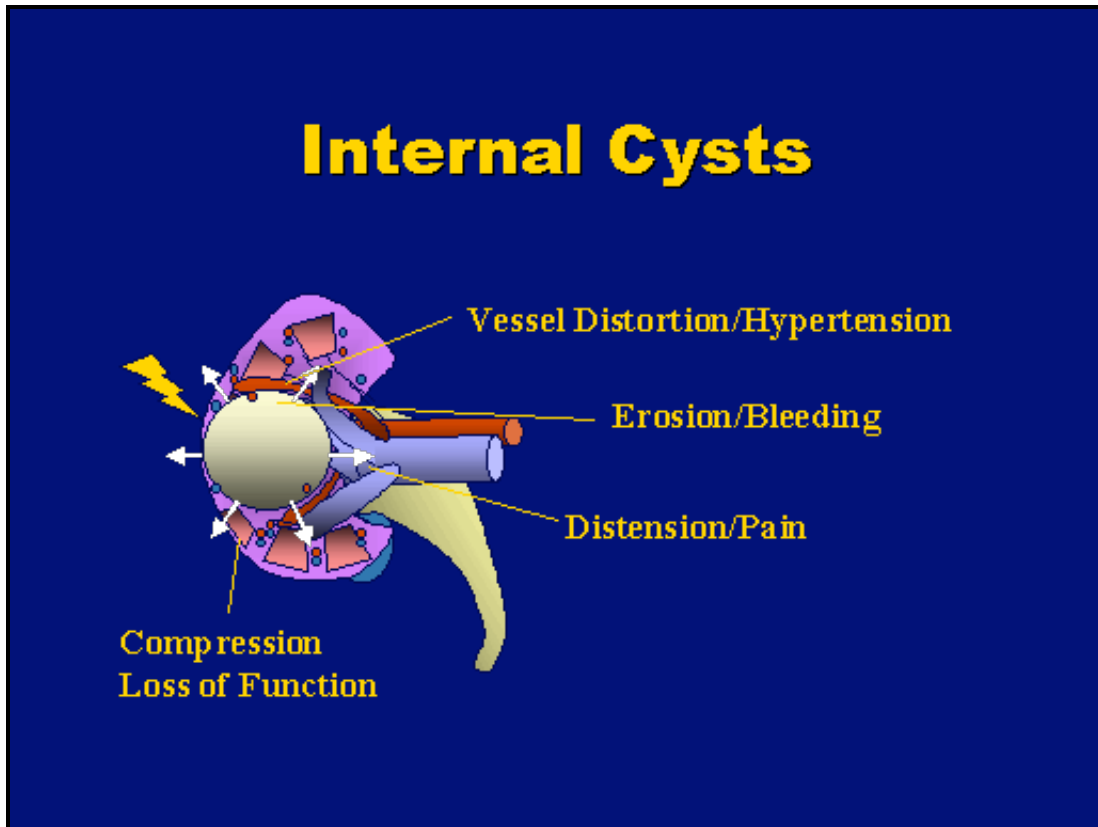
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Postoperative result

Postoperatively, this is with contrast so these are kidneys lighting up because of the blood flow in them. Those big cysts are gone. There is a lot of inflammation here instead from the operation and a little more room for the guts. More importantly, the pain was gone. So even though this is far less significant looking than that first CT I showed you, that person was incapacitated with pain.

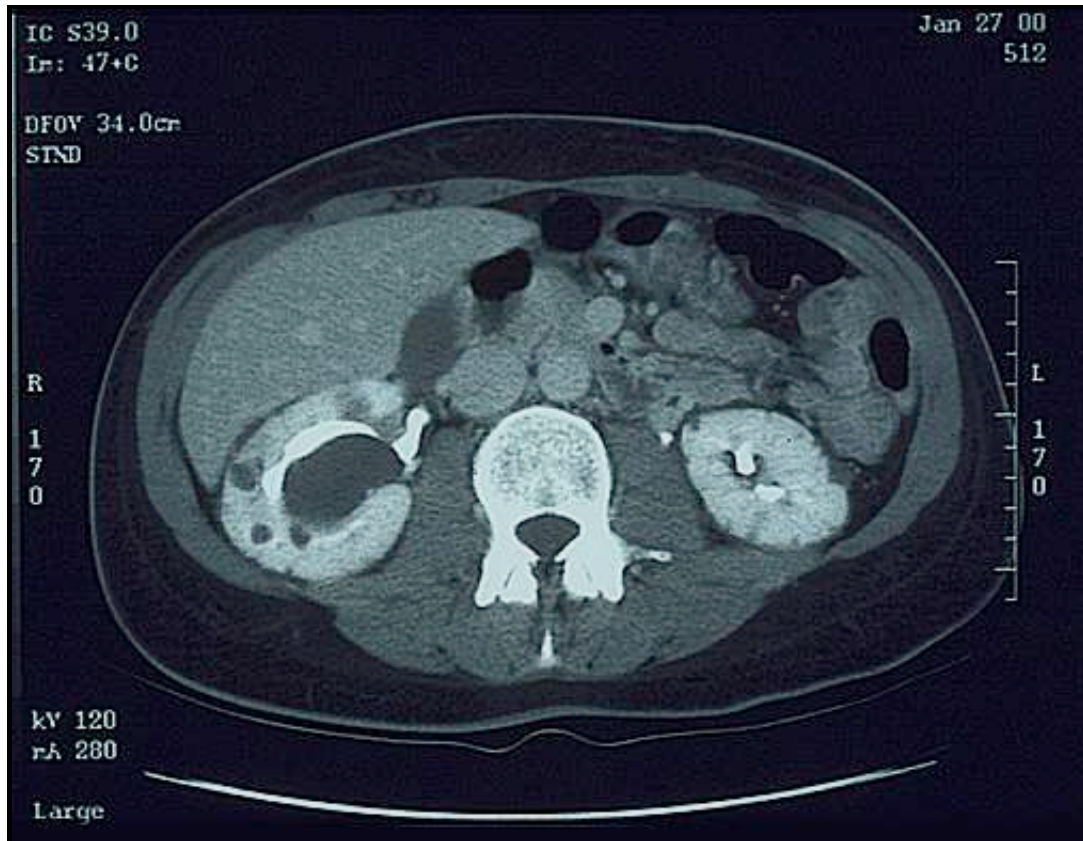
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Problems with internal cysts

The cysts on the inside--you can't see them, but they can still cause a lot of pain by pressing out on everything. They can distort blood vessels and partially make the kidney think it is not getting enough blood flow, which makes things to make your blood pressure go up so the kidney will get enough blood flow. It is a trick played on your kidney by the cyst that helps drive hypertension. There is a lot of trouble that happens with these, and these are the hard ones to deal with.

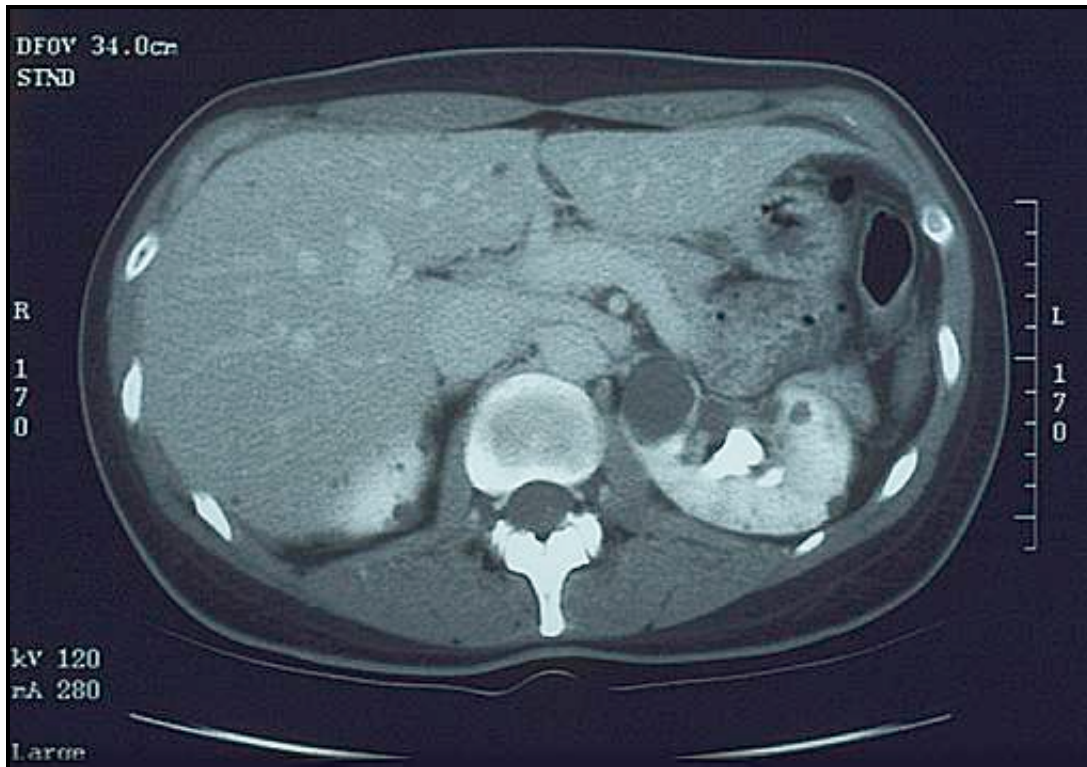
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Example of internal cyst

This one caused a tremendous amount of pain. This is what they call the collecting system where the urine is made and collected inside the kidney. Then it comes out of the kidney and goes into the ureter. And you can see that it is pinched very thin by this great big, central cyst, which caused just excruciating pain. This one we basically had to drain because there was no way to cut the kidney open enough to get that exposed. So we drained that and sclerosed it with a solution that would destroy the lining of the cyst.

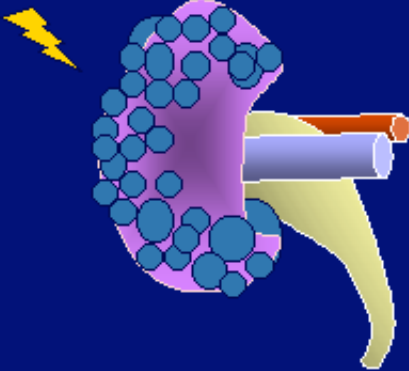
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**Another example of an internal cyst**

This one was not only central but had bulged out so much that it was becoming peripheral, as well. So this one turned out to be a little bit easier to deal with. We just opened that one up and made it go away.

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Numerous Small Cysts

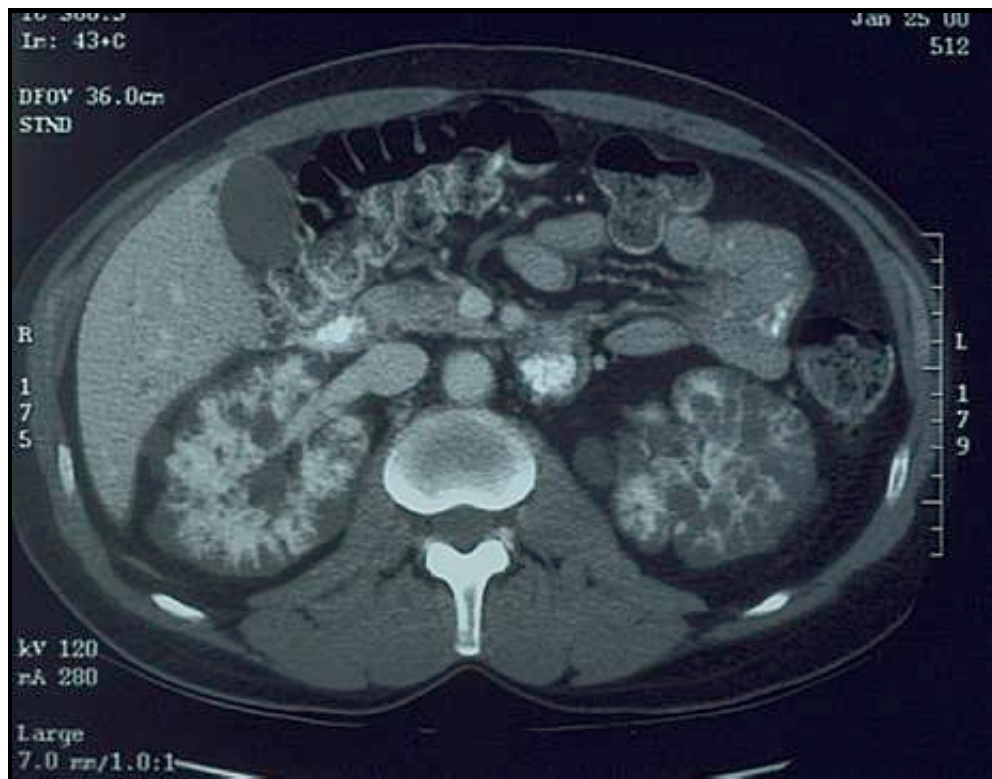


- Gradual Replacement Of Functional Kidney
- Significant Capacity For Pain
- Infection Risk

Problems with numerous small cysts

What about the numerous small cysts? If it is big enough, you can get to it. What if there are a bunch of tiny ones?

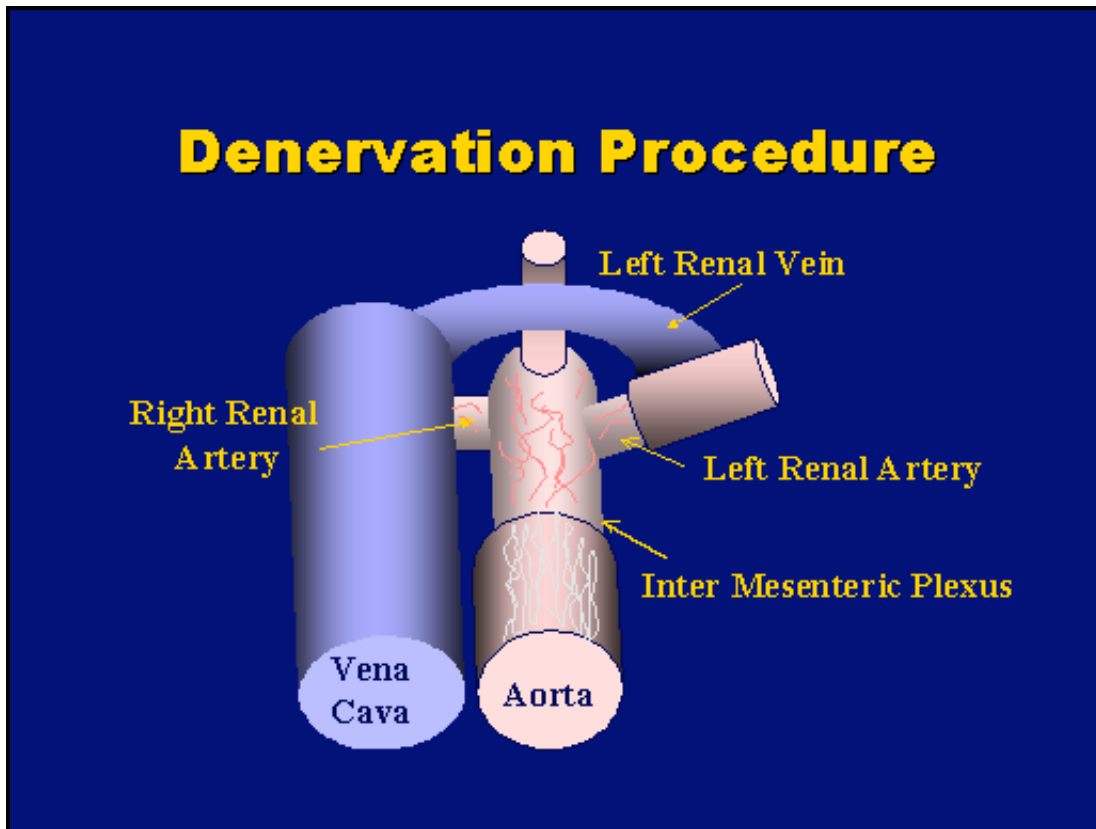
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Example of patient with numerous small cysts

We had one patient who had been through that open operation where they used to do this through a big incision. It helped him for about five years. Then for the last five years, he was having excruciating pain again, normal kidney function but lots and lots--innumerable small cysts was the way the radiologist read this. As you can see, there aren't those big bulges coming off of this. So what do you do for that?

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**Renal denervation**

What we tried to do for him, and for him it worked, is we did something called renal denervation.

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Renal Denervation

- No significant physiologic impact
- No additional morbidity
- No additional risk
- Adequate relief of pain (initially)
- **Chance of nerve regeneration**
- **Not easily repeated (perhaps)**

Basics of renal denervation

Renal nerves not critical: in transplantation they are routinely cut

When you take a kidney out of the donor and give it to a recipient in a transplant, you don't attach the nerves. So how come the kidney works normally? Because the nerves probably do things that aren't necessary for the normal function of the kidney. There are normal things that the nerves do that are necessary, like that is how you sense pain. And you would like to know, unless it is chronic, whether you have an acute reason to have kidney pain. But if it is becoming a problem, cutting those nerves does not damage the function of the kidney; it must take away the sensation of pain. So far when we have done this along with other operations, there has been no added difference. Patients haven't felt worse, looked worse, spent more time in the hospital. There doesn't seem to be any additional risk if you know what you are doing. I will point that out.

Adequate relief of pain initially is what we are getting, although this is not something that has been done for a very long time and it is important to recognize that we are just sharing with you some advances. This kind of goes along with this morning's talk about C- myc, things like that. This is something that a few brave souls who had no other option went through but not something that they had any data whatsoever to tell them how long it was going to make the pain stay away.

The person in question here was actually disabled and planning to have his kidneys removed and just getting a transplant because even though the kidneys worked normally, they were ruining his life and he couldn't go to work.

Renal nerves can grow back

There is a chance that the nerves can grow back. We do a few things to try to make that not happen. And we don't think that this will be an easy thing to repeat once you have done it, and I will show you why.

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Key Elements of Renal Denervation

- Laparoscopic trans-peritoneal approach
- Ultrasonic shear resection
- Circumferential arterial dissection
- Complete from inferior mesenteric plexus to superior mesenteric plexus
- Bilateral aortic procedure, selective peri-arterial procedure

Procedure of renal denervation

You go right across the abdomen. We used the ultrasonic shears to "scream" the nerves apart so you don't just simply snip them and let them lay next to each other, the two ends, so they'll grow back.

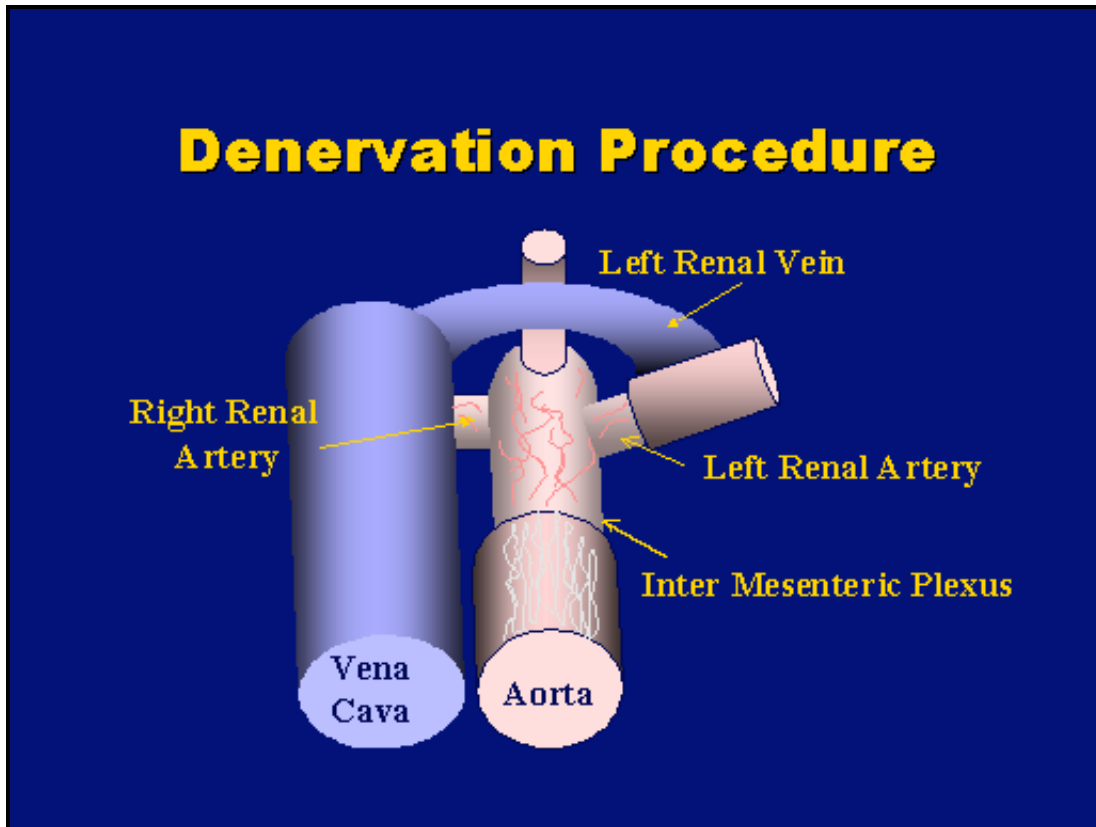
Nerves in abdomen give only vaguely localized sensation

The interesting thing about nerves in your abdomen is that they may be kind of dumb in that all you feel is "ouch" or it hurts somewhere around here--it is not like your fingertip where you know whether it is hot or cold or pinprick or dull or a hammer or the left side of the tip of your index finger versus the right side of the tip of your index finger. All of that you can tell. Right? In the abdomen, it is not nearly that smart.

Abdominal nerves are sturdy, grow along arteries, and tend to grow back

The problem is they are a little more sturdy and then tend to grow back. You think about cutting off nerves to things and they don't grow back, but in the belly they do. And so having them come back may be an issue. So we try to get rid of every last one of them. As Dr. Torres showed you, they grow along the artery. There are a whole bunch of others we will go into.

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Example of a renal denervation procedure

(Intraoperative slides not available)

This is a view through the camera. This red blush coming up here is the aorta, the major blood vessel in the middle of the abdomen. And this great big thing coming across here is not really that big. It is very magnified. That is the vein coming from the left kidney. There was a branch going down to this person's ovary that has been divided to help lift this up, which you can do and get away with. And then further up, a little probe in here to lift the vein up. Then we got around and found the artery to the left kidney and started to strip away all of the nerves coming down from that artery all away around it.

Then we went right down onto the aorta itself and lifted off this sheath of nerve fibers, grabbed it with... this is actually what the Harmonic scalpel looks like; bit down--that looks like big alligator jaws; then turned it on and clipped them away so that they were gone. What we do is basically we start low down on the aorta. We go all the way up to the artery going to the intestine, and we take it out on the right side and left side, all through the same approach.

Then this big bundle of nerves around all these blood vessels has been removed. It is multiple and sinewy and there is just lots and lots of little, tiny criss-crossing spots. You really have to be fairly aggressive about taking stuff out to get all of this. But once you do, the pain goes away.

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Potential Complications of Renal Cyst Reduction

- Abdominal bleeding
- Hematuria
- Partial or complete loss of kidney function
- Slow return of intestinal function
- Prolonged nausea (days)
- Infection

Potential complications of renal cyst reduction

There are complications of any operation:

- Bleeding. A lot of times when you are dealing with cysts deep in the kidney and you are really working on them, there will be some blood in the urine afterwards. We luckily have not seen this, but it is possible to bugger up a kidney and lose it, right? Especially when you are doing that with the arteries.
- Slow return of intestinal function.
- Sometimes people are nauseated for awhile.
- You could get infected. We are very careful to continue antibiotics against every known organism the patient has ever been infected against or with for many days around the time of these operations. Because if you are opening up a cyst that had a couple of bacteria in it, you will restart the infection again.

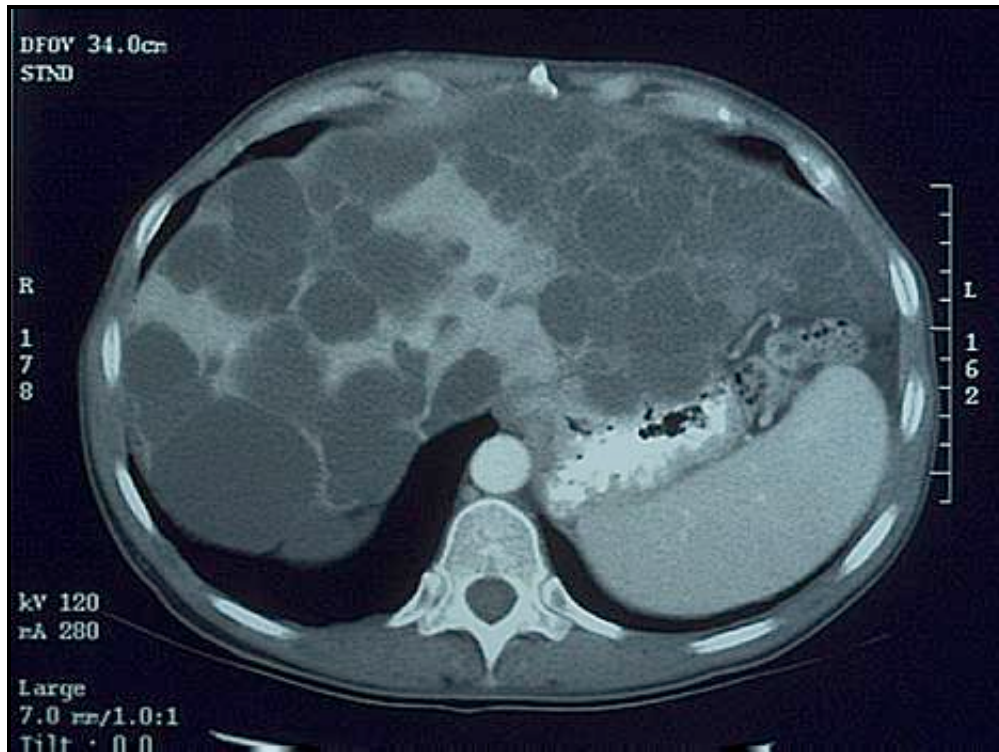
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Liver cysts

What about liver problems? You have probably seen a few slides about liver. This is a person who has polycystic liver disease. They have lots of cysts in their kidneys, lots of cysts in their liver. Their stomach and all of the other stuff that is supposed to be in there is all kind of crushed back here, way down near the back. So this person really couldn't eat very well. Every time she tried to have a full meal, she had to stop about five bites in. Subsequently, she was pretty happy that she hadn't gained any weight even though her liver kept getting bigger and was a little surprised to hear that is because all this muscle went away and she has no fat anymore and the reason she wasn't gaining weight is she was really losing a lot of her own normal body while the liver was growing.

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So the preoperative evaluation for this is all very similar, but we are a little more careful with the liver. You can see here the stomach crushed. This is a cut higher up that doesn't have the kidneys on it. Here is the stomach all squeezed down next to the aorta. The rest of this all looks like cysts. But there is normal liver in between. The important thing to remember is that, as you heard today, the same amount of normal liver that you would have if the liver were normal looking. So where did it go?

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Here we are all the way down in the hip bones, down in the pelvis, and here is liver still with a few cysts in it. There is a big chunk of normal-looking liver down there. What is it doing down there? Well it didn't just move. It didn't get pushed. It actually grew. That is why the kidney doesn't do so well with polycystic disease. It doesn't tend to grow back. The liver is a little bit like an amoeba. You trim off one end of it, and it wants to grow back. So if you damage one part of it tremendously, the rest of it will grow larger to make up for it. That is why if you noticed in the bar graphs, it seemed like the exact same amount of liver no matter what kind of problem you had. It is because the liver knows how much it needs to be.

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There are some other x-rays that you can do. You can take that CT scan and cut it like a plane going right down the front, like if you were to walk through a glass plane and were able to take a little section out of you. So here is the person's heart and there is their lungs. They are facing you. That is their head and body. Side to side is a cut right through. Here is a great big branch of one of the veins, what is called the portal vein, that goes all the way down into the pelvis. That vein doesn't normally look like that obviously. Normally it is up here. Then you notice this is lots of liver, and over here there is not so much. So as we kept working on this person, we found out that if you took a cut the other way--this is the front and the spine is back here--and you got off to the left half of the body, there was no liver at all--it was all just cysts. And that is fairly common.

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**Liver-spleen scan to identify location of functioning liver tissue**

In order to confirm that, we did a liver/spleen scan. And here is that great big amount of liver in the pelvis, on the right side of the liver. There is a little blush of the spleen. All this material that was sitting out here that you saw on the CT scan doesn't light up at all because there is no normal liver in it.

So what we did with that person is we put in some other trocars in slightly different spots because the liver in some people is a lot further down than it is when you have a normal liver. And a lot of times, you have to start out a lot lower and gradually work your way up as you make the liver smaller.

When we took a look inside, this is what we saw. This is the front of the liver. This was as far away as we could get because it was pretty much filling the abdomen. This little ligament here is a division between the left half of the liver and the middle and the rest of the liver. We can go right down that and just shave off every thing to that side and get rid of it, which we did. That made space for the stomach and a few other things.

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Key Elements of a Liver Cyst Reduction Procedure

- **Preservation of Renal Blood Flow**
- **Mobilization of Liver**
- **Resection of Cyst-replaced Segment(s)**
- **Decompression of Peri-gastric Space**
- **Judicious Ablation of Cut-surface Cyst Lining**
- **Duplex Examination of Liver and Vessels**
- **Aspiration / Sclerosis of Central Cysts**
- **Argon Ablation of Superficial Central Cysts**
- **Liver Biopsy**

Key elements to keep in mind when surgically reducing liver cysts

The important things, again, are

- To preserve the blood flow to the kidneys because in most cases it coexists with polycystic kidney disease. And if you are not doing anything for that person's... she had terrible looking kidneys, but they weren't hurting her so we left those alone. You've got to get around that big liver, which takes some time.
- You resect (remove) the chunks of liver that have mostly cysts rather than just popping the cysts, they don't tend to come back as much. Just popping a couple of cysts on a liver problem is not getting you anywhere. This is a big trouble, and you need to really be fairly aggressive about it. At the same time, you need to not tip the scales over to the point where the amount of fluid that is dumping into the abdomen is more than the kidneys like. Because if you rob the kidneys of enough of their liquid, then they will get sick.

Actually most people who have been in centers that deal with a lot of patients like this have seen at least one person killed from an operation like this done the wrong way. So this is not, "I happen to have some cysts in my liver, and it hurts a little, what do you think I should do?" This is something you really take on seriously.

- Making room for the stomach so you can eat--that is important.
- If there are cysts on the cut surface, the surface that you've cut out, you've got to be fairly judicious about burning those up. If you've done it appropriately, you've taken the artery and the vein and the bile duct to that part of the liver. So the only pieces of cyst wall that are left are hanging in the breeze. They don't have anything to live on any more. So you really don't need to be too aggressive with them. On the other hand, you need to take a look at all of the blood vessels and the rest of the liver, aspirate and sclerose any cysts you can't reach. And then anything superficial that is big, you want to un-roof--take the cyst wall off of and then cook the inside. But you have to also be judicious about that because the more times you do that, the more

times you will have cysts that weep liquid afterwards and the more liquid collection (ascites) in the abdomen you will get later.

- Then we usually get a liver biopsy just to prove that there isn't anything else going on in the liver. The vast majority of people with polycystic liver disease don't go into liver failure, don't need a liver transplant, don't have problems like that. But if there is anything going on that makes us suspicious, and it is not impossible unfortunately to have polycystic liver disease and hepatitis, which means that you might wind up needing a liver transplant and it is good to have a biopsy if you are in there.

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Potential Complications of Liver Cyst Reduction

- Ascites
- Abdominal bleeding
- Slow return of intestinal function
- Persistent GI symptoms
- Renal dysfunction or failure
- Infection
- Death

Potential complications of liver cyst reduction

Afterwards you can collect liquid in the abdomen (ascites). That's what that means. You get bleeding. It takes a long time to get over the operation, again with all the nausea and everything. Renal dysfunction or failure is possible. So we have to be mindful of all of this. Again, infection is possible. Again, antibiotic coverage is important. Both Dr. Bennett and I, who work at Good Samaritan and came from different institutions--both of us have seen a person in our previous institutions not make it through this operation. So that is two that I know of. Unfortunately people don't tell you about that as much.

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Other MIS Applications

Nephrectomy

- **Unilateral**
 - **Pain, mass, infection, hypertension, bleeding**
 - **Healthy kidney donor**
- **Bilateral**
 - **PCKD pre-transplant**
 - **Suspicious Masses in ESRD or Toxin/Balkan Nephropathy**

Nephrectomy using Minimally Invasive Surgery (MIS)

Now that we have this neat little set of toys and instruments and tools and a room and all this stuff, what else do we do? Sometimes people just don't need that kidney any more. It is not working or it is overly infected or there is a problem. Taking one kidney out is very easy to do. You can get rid of pain. If there is a mass, God forbid a tumor, that is sometimes a reason to do it. Infection. Hypertension that won't go away despite lots of medications after the person has been transplanted. Bleeding that won't stop.

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Donor MIS Nephrectomy

- Hand-assisted approach
- 2.5-3 hours operative time
- Right or left kidney now acceptable
- No more than 2-3 arteries
- Multiple veins usually not problematic
- Discharge day 4 after surgery
- Pain Rx for Tylenol®₁, ± Celebrex®
- Mean Warm Ischemia: 80 seconds

LGSB Current Practice and Results, Portland OR

MIS for donor nephrectomy

You don't have to have polycystic kidney disease--you can also be a healthy kidney donor and have it done laparoscopically now, as I am sure you have heard. You can also take out both kidneys, go bilaterally as we showed you. There are a lot of cystic conditions, not just polycystic kidney disease, which predispose to renal malignancy, which needs a more aggressive approach to removing any suspicious mass that is new and keeps getting bigger, just to make sure it is not a cancer.

For donors it is particularly helpful. Those of you who went to the transplant talk heard from Bill Bennett today that your spouse can donate you a kidney now with results that are almost identical to getting one from your mom, your dad, your son, and probably three-quarters of your brothers and sisters. It turns out that the old-fashioned living related kidney donation, the thing that was most important was the "living", not the "related". As Bill says, there is something--you wouldn't think it, but there is just something about dying that is bad for your kidneys.

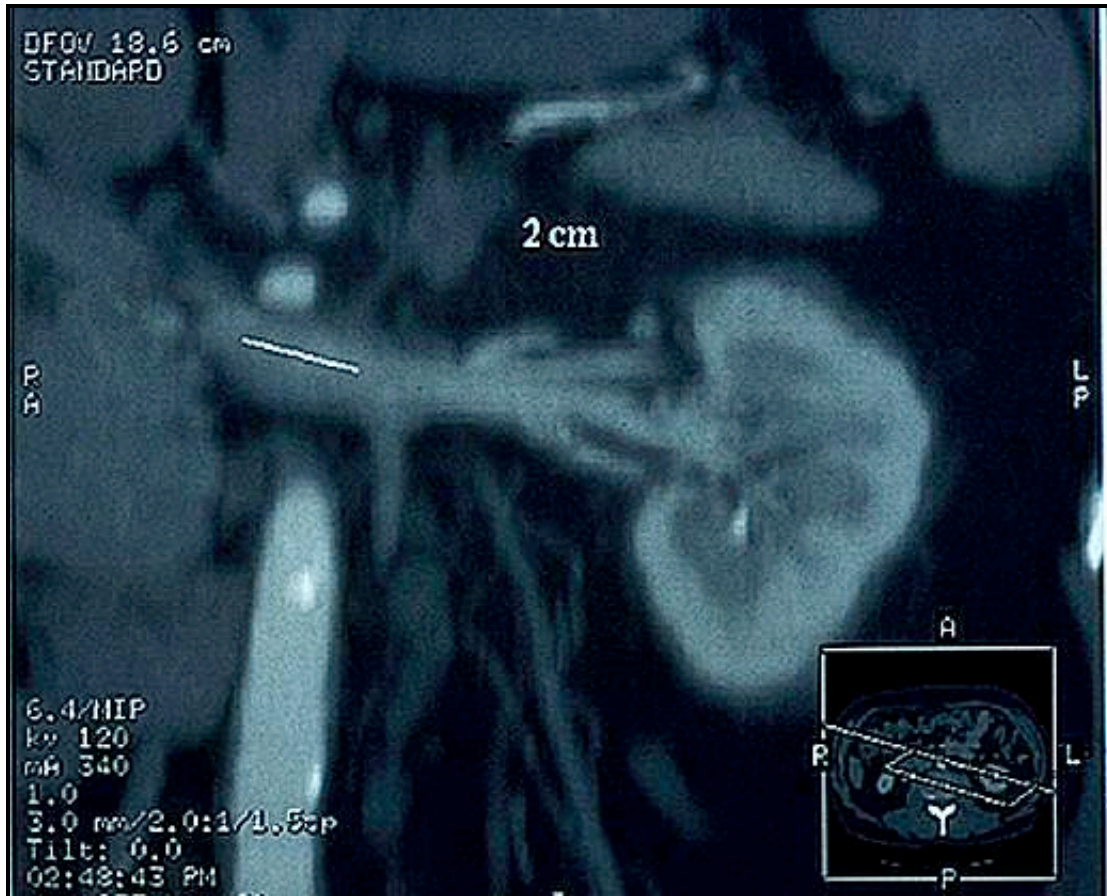
So we tend to use the hand-assisted approach here, too. It is safer, doesn't take very long to do, although it does take a little bit longer than the open way. You can get either kidney. We don't like to have 8 or 10 little arteries going to it. It just makes it tough, actually either way, open or closed, to deal with it. Multiple veins are not a problem. Patients usually go home very quickly.

There was even a report recently of a hospital in Washington D.C. that is kicking folks out of the hospital in 23 hours. Now that sort of smacks to me of the good old days when you got pregnant and delivered and you had to leave before your day was up. We like people to stay because usually it is the spouse who is donating and they like to learn the medicines along with the recipient in the family. So it is nice to have them in the hospital getting the same education. The pain treatment that we have sent all the people home on so far have been either a COX-2 inhibitor or just plain Tylenol. Nobody has gone home on narcotics of any kind.

The amount of time from clamping the artery, which is the first thing that we do, to having the kidney out, on ice, and flushed and ready to go in the recipient room on average has been 80 seconds.

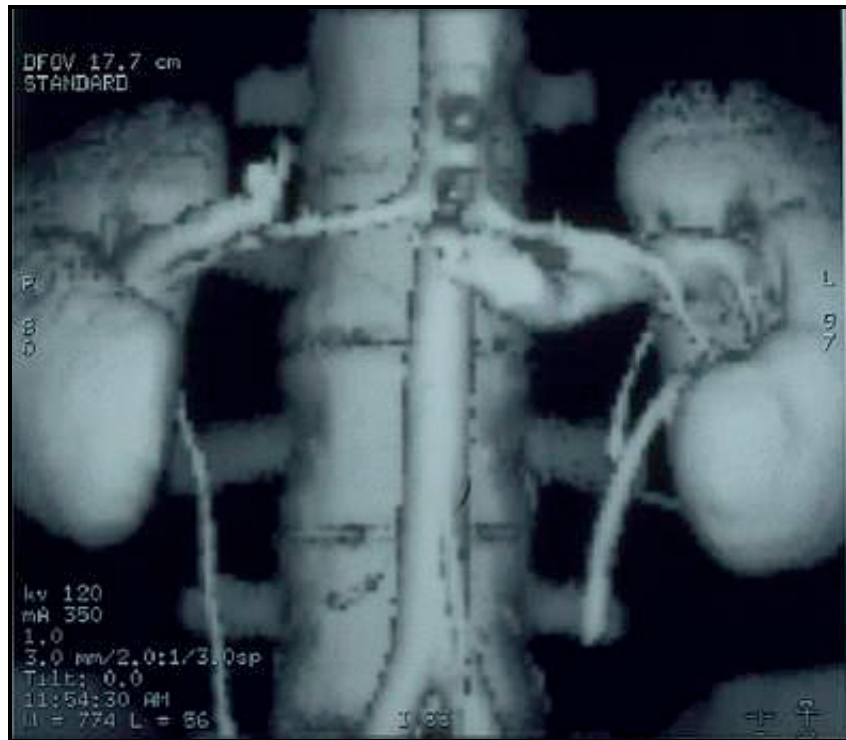
You can tell a lot about these kidneys. This one is a little dark. But here there is a picture of the kidney with the vein going right to where the first branch is--that vein that we showed that was clipped in that first picture.

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This is the x-ray of that. You can tell exactly how many cm of vein you have. You can see additional arteries very clearly. If there is more than one artery going to the kidney, you can pick that up beforehand. You can tell exactly how long an artery is before it branches on these CT spiral angiograms.

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You can do a 3-D reconstruction and find out that this kidney has two ureters coming out of it, and this one has only one, if you twist it around the right way. This allows us to pick which kidney we want. So in doing this, we have also done away with the good, old-fashioned angiogram, where people got stuck in the leg and had their artery scored. That doesn't happen any more either. So things are a lot better for your potential donors if you ever need a transplant nowadays.

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Why “Minimally Invasive”?

- Magnitude of Procedures
- Improved Technology
- Reduced Systemic Disturbance
- Peri-operative Discomfort
- Post-operative Discomfort
- Recovery Time
- Treatment is a Process, Not an Event

Concluding remarks

With all of this, I stress is what you do at that far end of the spectrum, either for the donor, when you are getting a transplant, or for you when you need something major done like a kidney out or some major pain problem taken care of. This is not the routine thing for everybody, and some of this hasn't really been done very long. So a lot of it is kind of like the mouse research that you keep hearing about. We are just holding on until the mice tell us exactly what we should be doing for you. Okay? Alright. (Applause.)

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