NARRATOR

Thank you for joining us from Brigham and Women’s Hospital in Boston, MA, to view the minimally invasive rotating platform total knee replacement procedure. Total knee replacement is a serious operation that offers many patients an almost immediate improvement in their quality of life. In the past, TKR surgery involved significant incisions to the knee and caused trauma to the surrounding tissue, which resulted in long, painful recuperation periods.

THOMAS THORNHILL, M.D.

Today we’re going to be doing a total knee replacement. We’re going to incorporate some innovative aspects to it. #1, we’re going to be doing this through a minimally invasive approach. #2, we’re going to be doing a rotating platform knee, which is a slightly different concept. The third is that we’re going to be introducing some of the uses of computer aiding for visualization, alignment, and many of the technical aspects of the knee arthroplasty.

NARRATOR

Dr. Thomas S. Thornhill, Chairman, Department of Orthopedic Surgery, Brigham and Women’s Hospital, and Professor of Orthopedic Surgery with Harvard Medical School, will narrate the procedure. Dr. Wolfgang Fitz, an orthopedic surgeon with Brigham and Women’s Hospital and an instructor in orthopedic surgery with Harvard Medical School, will perform the surgery.

WOLFGANG FITZ, M.D.

We do allow some sports. There’s no doubt about that. We have patients that play basically nice ground line tennis or they do cross country skiing or swimming. I wouldn’t recommend water skiing, for example. We try to reduce any impact sports, such as basketball and squash, but like skiing, we have patients that ski. Golf is not a problem. There is no impact. It’s actually good to walk on soft surfaces, so this is mainly encouraged. Riding a bike and swimming are other sports that patients can do.

NARRATOR
THOMAS THORNHILL, M.D.

Hello. My name is Dr. Thomas Thornhill and I’m chairman of the Department of the Orthopedic Surgery at the Brigham and Women’s Hospital. Welcome to our sixth live surgery webcast. The surgery being performed today is a minimally invasive rotating platform total knee replacement. My colleague, Dr. Wolfgang Fitz, will perform this procedure. Dr. Fitz is one of several of us here at the Brigham who do these procedures. Our patient today is a very nice lady who has severe arthritis of her right knee. She has failed conservative treatments or nonoperative treatments and she has a significantly impaired quality of life with limited mobility, severe pain and stiffness secondary to this arthritis. Total knee replacement is a resurfacing procedure which will repair or replace the arthritic aspects on the femur and tibia of the knee joint, as well as the patella. Today we’re going to be looking at some of the newer technologies that have been talked about in knee replacement in the past few years. Specifically, we’re going to be using the minimally invasive incision. Secondly, we will be doing a portion of this demonstrating computer navigation techniques. Third, we’ll be using a rotating platform knee which, while not new, is a slightly different concept than some of the standard fixed bearing concepts.

The important thing to stress here is that there are principles of knee replacement and these principles of knee replacement are critical regardless of the implant. In no way can we let these new technologies compromise or mitigate our ability to achieve the principles of knee replacement.

Throughout this live webcast, we will be responding to email questions. If you have a question, please click on the button at the bottom of your screen and one of us will try to provide you with the information. Also, CME credits are available through Harvard Medical School with this live webcast for the next 24 hours. For more information, click the CME button on our website.

The ground rules of the webcast today is we want to demonstrate the principles of total knee replacement. We want to show the potential and the concerns of these new technologies and we would like to underscore both the scope and the magnitude of this procedure. Our audience will be orthopedic surgeons and rheumatologists, primary care physicians, patients, and families and friends of patients.

The indications for total knee replacement are relatively straightforward. They include severe arthritis. The patient must have failed conservative or nonoperative treatment. There can be no active infection. The patient must be willing to have a lifestyle that is compatible with the limits of our current technologies in total knee replacement. This is a very good operation. It gives excellent pain relief. It restores the activities of daily living. It has a longevity that is equal or better than total hip replacement. The failure rate of knee replacements is roughly 1% per year. Now, knees may fail by a variety of methods.
Some patients have a lifestyle that’s just too active for our current implants. Infection, while significantly less than 1%, is a cause of failure, as is loosening or wear. Then some technical issues of malalignment and soft tissue imbalance. Those will be things that we will be stressing a great deal today because that is really the essence of the technique of knee replacement.

Now, minimally invasive techniques have been highly popular and highly publicized. The benefits are the potential for earlier rehabilitation with less soft tissue dissection, but you must remember that it should not limit the exposure and it should not compromise the ability to achieve the principles of knee replacement. With the smaller incision, there is always the potential for skin damage.

Now, the computer-assisted techniques in surgical navigation theoretically can give us more predictable cuts. It facilitates viewing in minimally invasive techniques. It does take a little bit longer. It’s not quite as good, in its present technology, for determining rotation or soft tissue balance.

Now, rotating platform knees have been around for over 25 years. Their advantage is the idea that they have better contact area and, hence, less contact stress. They are forgiving in tibial rotation. We will demonstrate that. The concern of wear or backsided wear in a rotating platform knee is controlled because it’s against a second bearing surface. The concerns of rotating platform knees is that they are a bit more sensitive to soft tissue balance and you do have, in fact, a second moving surface for the rotating bearing.

We have talked about the principles of knee replacement and there are many of them, but I think it’s best to look at five: First, proper patient selection to make sure that the patient is able to live within the confines of knee replacement. Secondly, you must obtain adequate exposure to see what you’re doing, whether it’s a minimally invasive technique or not. You must align the component correctly with itself and with the extremity. You must balance the soft tissues and, finally, fix the implant solidly to the bone. Now, these principles that we’ll demonstrate today are not really institution- or surgeon-specific. We must also remember that the new technologies cannot compromise these principles.

If you have questions, feel free to consult your primary care physician, your rheumatologist, your orthopedic surgeon, and we will try to help during this broadcast.

Now, since we only have about an hour, what we’ve already done is we’ve chosen the patient. The anesthetic has been performed. That’s a very critical part of this and makes it so that we can do these procedures. The preparation of the staff, the nurses, the technicians, and all of the people in the operating room, is critical in order for us to achieve this. We’ve already obtained the exposure. We have registered the computer and we’ll talk about that in a moment. In fact, we have already cut the patella in order to gain exposure in this minimally invasive technique.

When we talk about patient selection, a very important thing is to get a feel or a sense of the substrate or the tissues that you’re dealing with. For instance, here you see a patient.
You don’t see the x-ray, but you can see the knee. If we stressed the knee, you can see that this patient has a lot of laxity on the inside or the medial part of the knee, so in balancing this, we’re going to have to account and correct for that laxity. The other important thing that we’ve already done is obtain exposure. We’ve done this through a short medial incision in what’s called a tri-vector approach that did not violate either the quadriceps tendon, nor does it allow us to evert or flip the patella. We think that’s very important; in fact, more important than the skin incision. We have resurfaced the patella, or the kneecap, and we have obtained adequate exposure. Here’s a picture of a similar type of an exposure that we have done. You can now see this is a short medial incision in a right knee. Now we’re just opening the knee and beginning to see the cartilage surface. Here you now see the patella flipped. The patella, you can see the arrow showing the damaged area of the patella. We removed this with a cut and now you see the cut surface of the patella.

So during this webcast, we’re going to first cut the tibia and it will be the only thing that we will do with the computer-assisted, to show you this functionality. Then we will make the distal femoral cut. Then we’ll deal with the very important aspects of flexion and extension balance, rotation, final soft tissue balance, fixation, and then closure. You can think of alignment in several different planes and we must look at that, but you cannot separate the alignment from the balance of the soft tissues. One thing that is helpful is to take a three foot film, as you see here, that incorporates the hip, the knee, and the ankle joint. Then, if you draw a perpendicular from the center of the femoral head to the center of the trochlea, draw that line and then construct a perpendicular at the joint, that will tell you the relative proportion of bone that you’re going to take medially and laterally. You do the same thing on the tibia, to draw the tibial mechanical axis to the center of the talus in the center of the ankle joint and then perpendicular to that will tell you the relative amount of bone medially and laterally on the tibia, so at the end, if you draw a line from the center of the hip to the center of the ankle, perpendicular to that will be parallel to the implant.

So now our first cut is going to be on the tibial cut and we’ll be doing it computer-assisted, so I now think that we will go live to the operating theater and join Dr. Fitz.

WOLFGANG FITZ, M.D.

Hi everybody. Welcome to the Brigham and Women’s OR 37. Today we are going to show you a computer-guided, minimally invasive rotating platform total knee. The patient I’m operating on is a very pleasant 54-year-old woman who is very active and is actually severely disabled due to her knee pain. I have the x-rays here that show typically the wear here, on the inside of her knee. You can see that besides being bow-legged, she is bone on bone on the inside of the knee. You also can see that she has severe arthritic changes in the femoropatellar joint, so she is therefore not a good candidate for a unicompartment replacement. She is really a candidate for total knee replacement.

I will take you right now to the table and show you briefly what we have done so far and then cut the tibia computer-guided.
THOMAS THORNHILL, M.D.

We’re going to do this computer-guided. Let’s roll the first tape and we can show you what we mean by this. The first thing to do is to register, so the computer will understand. There are two arrays, one placed in the tibia and one in the femur. These are reflective balls. All of this is done with an infrared ray that goes between the wand that registers the arrays and the camera, and then reconstructs this on the computer screen, so this is not involving any fluoroscopy or x-ray and it will now link the two. So we will first do the mechanical axis to determine the relationship between the hip joint, the knee joint, and the foot joint. Then we size the femur and the tibia. Then we create a mapping of the various surfaces to generate a bone morph, if you will, which will now allow us to reconstruct on our model and our computer, and then we should be able to see all of the components of this in terms of alignment, not only of component to component, but sizing of component and then I think in the next iterations we will then be looking at soft tissue balance and probably better at rotation. Here you just see the mapping of the individual surfaces.

So I think that we can now go back and see how we’re doing in terms of our tibial cut in the computer-assisted.

WOLFGANG FITZ, M.D.

What I’ve done here is we have exposed the knee with a small tri-vector approach. Then we cut the patella, protected the surface of the patella – I’ll show you that later – with a little wafer, just to make sure that the hard pressure from this retractor that enables the dislocation of the tibia really does not harm the surface of the patella and the whole consistency of the bone. What you see here is, I have an external cutting alignment rod that we traditionally use. What I will do here is verify my cuts now with the computer.

THOMAS THORNHILL, M.D.

So Dr. Fitz, the reflective array that you’ve just put on the tibial guide will now be picked up by the computer and then go back and pick up the arrays that are on the tibia and the femur and then it will reconstruct that surface for you.

WOLFGANG FITZ, M.D.

Correct. What these arrays do is, they basically are fixed. We have here very thin pins. They are only 3.2 mm in diameter. Double pins here, so you don’t have a stress raise. So what happens is you go and register, as you saw on the video, and then the computer generates a 3D model. The same happens with the femur. So I just have to go really briefly through the computer. The computer asked me to hold this navigating took on the anterior cortex of the femur and now we go to the tibia. That’s actually what we’re trying to do. I can see now on the screen, and you will be able to see that too, how much varus or valgus, meaning how much off am I from my mechanical alignment? With this
alignment rod here, I actually can change, I think you can see how it works. You can see now, I want to have a 0° cut and you see that I am still not in varus.

THOMAS THORNHILL, M.D.

So, Wolfie, what you’re trying to do then is reproduce that line you have, which would be a neutral mechanical axis, and then on the lateral film, in order to reproduce the posterior slope, and then you can see when that blue disc then coincides with your proposed axis. Is that correct?

WOLFGANG FITZ, M.D.

Yes, that is correct. What you see here is that the navigator shows me now an alignment of 1.5° off and I correct this a little bit more. See, now we have 1° and now we are almost down. So now I’m going to pin this. My varus alignment is now good. I am perpendicular to the mechanical axis.

THOMAS THORNHILL, M.D.

So now you’re pinning that cutting guide into position.

WOLFGANG FITZ, M.D.

Correct. I pinned one pin laterally, as you can see, and now I’m really perpendicular to the mechanical axis. Now, the second thing I have to adjust is the slope. You can see on the screen that the slope is actually 4°. Too much and I decrease this.

THOMAS THORNHILL, M.D.

This is your upper right screen that we’re looking at here. We see we’re at 2.5 now, so we can adjust this and then we’re going to go ahead and cut our tibia.

WOLFGANG FITZ, M.D.

Right. Now I’m going to pin my second hole of my cutting block. You just have to be careful, since the incision is so small, you have to make sure you don’t perforate the skin and somebody has to retract the skin. Okay, so now we verify our cutting block.

THOMAS THORNHILL, M.D.

Wolfgang, while you’re getting ready to cut the tibia, let me just address...we’ve had several questions and one of the questions, from a patient in Southborough, MA, is can a person who has had a femoral osteotomy have this procedure? A femoral osteotomy is a procedure that changes the angulation of the femur and, in fact, is one of the things where this computer registration and the ability to cut this would be, in fact, very good, so not only can they but oftentimes it’s a good functionality.
WOLFGANG FITZ, M.D.

I agree with you. The computer guidance is good for the mechanical alignment, but the problem with HTOs is really that the small incision is very, very jeopardized by the first surgery, so I think that these patients, we should really wait to offer them minimally invasive techniques.

I’m going to cut the tibia now. One of the principles I want to show you here is that we really have protected everything we have. The MCL is protected with the C-retractor. The PCL is protected with the straight Homan. You have the popliteus and lateral collateral ligament protected with that bent Homan and I have the patellar tendon here protected. I cut the medial side first.

THOMAS THORNHILL, M.D.

Now, we’ve just cut the tibial component and showed the protection. The MCL is the medial collateral ligament. The PCL is the posterior cruciate ligament, which we will preserve with this technique. The popliteus and the lateral collateral ligament are on the far side of the wound. The patella is just underneath the retractor on your left, so now we’ve removed the proximal or upper part of the tibia and done it exactly in the alignment.

Wolfie, can you show us the arthritic aspects of this bone?

WOLFGANG FITZ, M.D.

Sure. Here you can see, actually, that the medial site is bare bone and even the lateral side, here, is severely eroded. What I, the resected bone I just used to template the size of the component, so give me a size 2 tibia please. The next step will be, we verify our cut. A 2 fits nicely. Maybe a 2.5. I’m going to verify now my cut. I have this little thing here, my navigator. Hold it on the cutting surface.

THOMAS THORNHILL, M.D.

So this is again demonstrating the ability of the computer to verify that the cut was made at the intended angle.

WOLFGANG FITZ, M.D.

Here you can see that my cut was really just $\frac{1}{2}$° off and that actually is what we want. We really can reproduce excellent mechanical alignment. So the tibia cut is done and now we’re going to go to the femur.

THOMAS THORNHILL, M.D.
As we’re getting ready to move to the femur, we talked about the question about a femoral osteotomy. What Dr. Fitz was saying was that, in terms of minimally invasive techniques, it would depend upon the other incisions, but in terms of computer navigation, this is oftentimes a good functionality.

Another question that we have is from Manchester, New Hampshire, from a patient who says, my wife is 70 years old and is interested in knowing if both knees can be done at the same time. The answer is, it really depends upon the overall health. It depends upon the institution. It depends upon the availability and, in many institutions, including this institution, we frequently do bilateral total knees, but that really has to be individualized.

Now, as we go through, we see Dr. Fitz is making his distal femoral cut. He’s drilling a hole into the intramedullary portion. Then we’re going to do measured resection based off that intramedullary guide. He’s just opening that hole a little bit. Our goal here is to be perpendicular to the femoral mechanical axis, so we’ll go back to our standing 3 foot film and see the line that was drawn from the center of the femoral head to the center of the trochlea or lower part of the femur and then that perpendicular you see will tell us the relative amount of bone that we want to take. Here you see a close-up of this line drawn that tells us that in this particular knee, which is the left knee, we want to take a little bit more bone medially versus laterally. Now, we can use the computer with this, but what we really want to do is to verify how the cuts that we take with our alignment measure with what we planned preoperatively or what we planned with the computer. So now, as we’re going into this, we’ll go back to the operating theater. Dr. Fitz is now putting in the femoral intramedullary rod and he is now going to determine what’s called the varus-valgus angulation of the femur.

WOLFGANG FITZ, M.D.

This is actually a traditional part of a total knee replacement, only the instrument is a little smaller. You may ask me, why don’t I use the computer. The thing is, we have this instrument right now, but the surgery is just a snapshot of what we are doing today, so with smaller instruments that will be available in the future, I don’t have to use, in the future, the intramedullary rod. So what I do here, as Dr. Thornhill explained, I do a measured reduction off my medial condyle and we resect, based on the principle, the size and thickness of the component.

THOMAS THORNHILL, M.D.

Wolfie, would you ever take a little bit more or a little bit less, based on, say, for instance, if a patient has a significant flexion contracture, might you take a little bit more?

WOLFGANG FITZ, M.D.

Well, actually you have to take more, but what I’m doing is, there’s a little tiny osteophyte medially which actually pushes the whole cutting guide more distal, so I just...
THOMAS THORNHILL, M.D.

I think it’s an important point, when you place that guide against the distal femur, to make sure that you were contacting the central portion of the most prominent condyle because if you’re on an osteophyte, it can actually make you under-resect, so I think this is a very important point. You see now Dr. Fitz is affixing the cutting guide to the femur, based upon the angulation that he has chosen for this patient and verifying what he had done from the 3 foot film. This is a traditional thing. You can see that the minimal incision has not in any way compromised his ability to see and perform these cuts.

WOLFGANG FITZ, M.D.

So what we do is perform the cut now. I just put the tibial tray in here to protect everything. I think one of the important things in minimally invasive techniques is to do everything to protect your ligaments. I have shown you on the tibia that we really want to protect everything, so now we are ready to make our distal cut and you see I have my medial structures protected.

THOMAS THORNHILL, M.D.

You can see that we are going through a slot in this. This will take a measured resection and take the amount of bone that we want to take from the medial size and the lateral side. You will see that there may be a little bit more bone on the medial side than the lateral side because this is what our preoperative radiographs showed and this is what is necessary. You see, there’s a smaller amount of bone coming from the lateral side. So at this period of time, based on our femoral cut and our tibial cut, we have really determined what is called a varus-valgus basis of this implant, assuming we balance the soft tissues.

WOLFGANG FITZ, M.D.

So this is exactly the next step, what I’m going to do. I’m going to measure my extension gap and balance the kneecap. What I do is, basically, I have a block that represents the thickness of the components and I put my 11 mm in here and what you can see here is that the block fits in nicely. It’s tight. I test here in varus and valgus stress, meaning that I try to open it, but it actually is very stable and the patient has full extension, so we can actually demonstrate that on the computer. You see here, I have not a lot of opening laterally and there is no opening medially, so we like that. So now, I actually take a newer instrument and I measure that gap and I take the so-called balancer, which actually goes a step beyond. The balancer not only will give me the exact distance in mm, but it also measures my extension gap in regard to the tension applied. So what I do here is, I insert that spring and apply a pressure from what I like. This is subjective, but I like that. What I can see here is that my resection is about 20 mm, which actually transfers to a 10 insert. However, I am a little tighter medially, performing this balancing, and I do think I have to release her medial structures a little bit more. So what I do is, I just make a medial release and then remeasure.
THOMAS THORNHILL, M.D.

Now, this is an important point. What we’re really trying to do, we’re going to get back to the principles that we’re talking about. That is, we must have balanced flexion and extension gaps. We must have the soft tissue under proper tension. This can be done a number of times. You can take the preoperative deformity and then do preliminary releases. You can do it now in terms of the flexion and extension balance. But really, the final test is at the end, when you place the component, so what Dr. Fitz is doing now is releasing the structures a little bit on the medial side. As a general principle, it is easier to release tight structures than it is to tighten loose structures, so what we tend to do then would be to release medially and then add a slightly thicker component. Remember, we won’t be elevating the joint line by doing that because the joint line is now already fixed by our distal femoral resection, so this is just a little bit of release of some of the structures on the medial side and the collateral ligament, a very important structure, you can see he was near the upper part of the tibia. That is not where that lateral collateral ligament inserts, so he has not violated the superficial medial collateral ligament. But after he does that, he’s going to use this tensioner. This can be done with any of a number of different techniques. This is the particular technique that Dr. Fitz likes. It’s important, though, that you do this both in flexion and in extension. How does it feel, Wolfie?

WOLFGANG FITZ, M.D.

I did a little release and I think it’s getting close. One of the problems of this tensiometer is that it really is a little bit, you know, it can lock in and you have to calculate the weight of the leg, so you really have to play around until it’s fine, but we are now balanced. I have a value of Type B, which is about 20 pounds per square inch, and I have a 10 on both sides, medially and laterally, so in extension this knee is now balanced. So I take this and translate this tension now into flexion and that’s what we’ll do next.

THOMAS THORNHILL, M.D.

While you do that, we’re going to talk about gap balance and the various landmarks of rotation. It’s important, when you look at the extension gap that we just measured and balanced the medial and lateral ligaments, and then there’s also the flexion gap, which is that with the knee bent. They must be equal, assuming that you’re using a component system that allows for equal flexion and extension gap. You can change the flexion gap significantly by rotating the femoral component. So while we’re doing that, I think we’re going to talk a little bit about the femoral landmarks and ways of determining the femoral rotation because that’s very important. It influences the flexion space. It influences the integrity of the flexion space. It influences the soft tissue feel. We must stress the word feel because what we’re talking about here is, we have tensiometers and computers, we’ll have all these things but there still is a subjective evaluation, depending upon the patient’s soft tissues to begin with. Then also rotation significantly affects patellar tracking.
Here’s a picture of the femur. There are several ways, but four major ways of determining the flexion space. One is, you can use the posterior femoral condyles. Now, that works well in a varus knee, not very well in a valgus knee because the valgus knee frequently has hypoplasia or deficiency of the lateral femoral condyle and that would tend to make you internally rotate the femoral component. You can use the transepicondylar axis, which is a very important axis to look at. That goes from the medial to the lateral epicondyle and it is the horizontal line that you see in your slide. Then there is the transtrochlear axis, which is the line between the bottom of the femoral trochlea and the top of the intercondylar notch, and that should be perpendicular to the transepicondylar axis. Then you can use the tibial surface and the soft tissues to do the same thing. This is what Dr. Fitz is doing. He will look at all of these axes, but he is using the tensiometer in terms of balancing it and doing it off the tibial surface because it’s the tibial surface along with the posterior femoral surface that’s going to give you the flexion space that’s got to be measured and be equal with the extension space. Wolfie, how are we doing?

WOLFGANG FITZ, M.D.

What you see here is exactly what you were talking about. I marked the so-called transepicondylar axis and you can see, even though the approach is very small, you can feel the epicondyles with difficulty, so I drew that line and, perpendicular to it, the AP axis, so I have now a lock that represents basically the height of my femoral component. I put it on and I know now that I want a flexion gap with a certain tension. This is the same tension that I had in extension, so I translate now this tension, in flexion, and base my cut on it. You can see here that I have a little difficulty exposing it. That is actually one of the critical points of this procedure, to make sure that you don’t notch, which is very, very important. A trick to see how much space you have up here is...

THOMAS THORNHILL, M.D.

When Dr. Fitz says notching, what he means is creating a notch in the anterior part of the femur. The reason why that is not good is it doesn’t really size the femur. It also creates what we call a stress riser and increases the risk of fracture above the component. So now we’re using the tibial cut, the transepicondylar axis, the transtrochlear axis, and he’s not reaching up and feeling the anterior portion to make sure that the anterior femoral cut will not cause a notch in the distal femur.

WOLFGANG FITZ, M.D.

That determines, actually, my sizing. Initially I was worried that the size 3 for this patient is a little bit too big, but I see that it actually fits quite nicely, so what I do at this point is, I just make my tool...we have to verify that it is perpendicular. Now I make two holes in the bone and we will be able to see the relationship to our transepicondylar axis. I remove this and what you can see here quite nicely, that is actually the fact in 90% of varus knees that the rotation here that I marked is basically along the transepicondylar axis. I’ll show you now a different method how to do this, where you just take a femur sizing block,
which is based on the posterior condyles. It just is 3° externally rotated and in 90%, these markings are correct for the femoral rotation in a varus knee. So we will put this on. We have here a stylus that actually can go in there and measure the size. It is actually somewhere in between. It’s almost a 3, so it’s actually the same as I felt before.

Okay, so what we do here is, I take now the 3° off the posterior condyles, which is this hole and this hole and then, when you move it, you can see that actually in this case it is exactly the same. So the tensioning is one thing that moves now the femoral component 1 mm more proximal, but I know exactly that the tension I like is what we need here.

THOMAS THORNHILL, M.D.

So Wolfie, I think we’re going to need to move on and cut our femur. I think the important point to emphasize here is that there are a variety of methods available for balancing the soft tissues and getting the correct alignment. The discussion between 3 and 4 is a sizing issue. That will determine the proper size. Fortunately, the component systems that are available throughout the world really have a variety of sizes, so you’re not completely bridged in by one size. I think that really is important because that balances the soft tissues.

So now that we’ve determined that rotation and confirmed it, we will now make the anterior cut. We have already made sure that isn’t going to notch. Then we can do this and there are a variety of cutting blocks that will allow us to make our anterior cut, our posterior cut, and what are called chamfer cuts or side cuts or diagonal cuts, which you will see as we put the implant on, are important. The other thing, as you will recall when we made our tibial cut, it was very important to protect these structures again, so you’ll see the assistants that are helping by protecting these structures and that’s a very critical part of this procedure.

WOLFGANG FITZ, M.D.

So what I did is, I cut for a 3, but I feel that I have at least 2 more mm here or 3 more mm, so I’m going to go back to a 2.5. I apply my tension again and just go one step back. This is not something that you should be ashamed, to go one step back. In minimally invasive techniques, you really want to be very careful about not notching, as we mentioned before, so I was not very worried but I just wanted to make sure that is the correct size, so I go back now to a smaller size here, the 2.5 cutting block.

THOMAS THORNHILL, M.D.

It’s not infrequent when we’re doing this procedure, you will see, that we will be between sizes. You can make a decision to use the larger size or the smaller size and that brings into play all the concepts of soft tissue tension and, again, underscores the fact that, while we have a highly instrumented system and we can take advantage of these new technologies, there’s still the feel and the balance and the intraoperative decisions that we
must make in order to achieve the principles that we talked about at the beginning of this webcast. For now, we’ll just revisit that anterior cut and see that we still are not notching.

WOLFGANG FITZ, M.D.

We are cutting now the four cuts of the femur. You can see that everything is protected. The next cuts will be the posterior cuts here on the femur. You can see the medial collateral ligament is nicely protected. The same, and actually the lateral side is more important, specifically if you do an RP, a rotating platform knee, there is one tendon, the popliteus tendon, and if you cut this, then your lateral flexion gap opens up and you have to be very careful. That’s why we put this in around the patellar tendon, to really protect it. Then we cut our posterolateral condyle. I cut my posterior chambers.

THOMAS THORNHILL, M.D.

So now we’ve determined that we’re going to use a 2.5. Now we’re going to begin to put the trial components in and check for the rotating platform aspect of it. Now, while we’re doing this, I think it’s important to talk a little bit about the posterior cruciate ligament, that most knee replacements in the United States, primary knee replacements, meaning the first time, there are different schools of thought. One is the school that saves or retains the posterior cruciate ligament, which is the school that we subscribe to, predominantly. Another substitutes for the posterior cruciate ligament. The clinical results of both of these have been excellent, but one of the things we feel is that the posterior cruciate ligament really serves as an important component of the flexion space. It is, in fact, the lateral ligament of the medial side, the more important side of the knee, because that is the side which is the rotation part of the knee. The problem with the flexion space is you have on one side the medial collateral ligament and, on the other side, the lateral collateral ligament and the popliteus, and they are different strengths.

Let’s roll that second video for just a second. I think it’s important and you can see these lamina spreaders that are in place. As we roll this video, what you can see is that this lamina spreader, as it tightens up the medial side, the lateral side will chase it. The lateral side of the knee is more loose than the medial side, but watch how the lateral side comes in and squares it. Then, if you bring another lamina spreader in, what you will get will be a little bit of additional laxity because the lateral side of the knee is, in fact, more loose than the medial side. We also have an issue that, remember the flexion space also involves the patellofemoral joint, which we have taken out of place, so let’s go back to the operating theater. Wolfie, we’ve got a little bit of time left here, so I think what we need to do is get on with our tibial rotation.

WOLFGANG FITZ, M.D.

Okay, what I do here is exactly what you just explained on the video. I basically put these lamina spreaders in and you can see that the flexion gap is equal and the posterior cruciate ligament is nicely balanced, so what I do here is, I clean out the posterior cutters,
THOMAS THORNHILL, M.D.

Wolfgang, while you’re cleaning out the back of the knee, let me just address a couple of questions we’ve gotten from our viewers. One is obviously from an orthopedic surgeon, who raises a very important point in saying, is rotation of the femoral component the same for a varus knee compared to a valgus knee. That’s a very important point. The answer is, in both of these situations you want to externally rotate the femoral component, but in a varus knee you do it as we saw here, by generally increasing the amount of bone that’s resected posteromedially, whereas in a valgus knee you externally rotate by decreasing the amount of bone that is taken posterolaterally. The one thing you want to avoid is internal rotation. Remember that in fixed bearing knees – we’re doing a rotating platform – you must then match the tibial rotation to the femoral rotation. It’s one of the benefits, but I think that’s an important point and I thank the viewer for it.

Here’s another question, talking about patellar resurfacing, saying do you always resurface the patella? We always resurface the patella. There are others who don’t and they need to be careful in terms of the type of system. Those who don’t resurface the patella routinely will be using a system that allows them to do that. In our studies, it looks like we feel that resurfacing the patella is of benefit.

So Wolfie, how are we doing in terms of getting the soft tissues out of the back of the knee?

WOLFGANG FITZ, M.D.

I’m almost done here. On the lateral side, you can see that the popliteal tendon is preserved and that’s very important. See, here is the popliteal tendon. The PCL, the posterior cruciate ligament, is nicely preserved here. I’ll just free it up a little so we get rid of that tissue here. Then we’re going to put our trial components in and then we are ready to put the final components in.

THOMAS THORNHILL, M.D.

Wolfie, can you just point to, for our viewing audience, the posterior cruciate ligament?

WOLFGANG FITZ, M.D.

You see, here is this white structure here, the posterior cruciate ligament. It’s really a nice thick tendon. So we are ready to go for our trials.
The viewers can see quite nicely with this minimal incision. There was another point made by an orthopedic surgeon viewing, and I think it’s a very important point, tension on the skin. I think it is one of the downsides of these minimally invasive incisions. Sometimes, depending upon the patient’s size, you actually have to make a little bit bigger incision. We think of the minimally invasive technique as not really size of the incision. You don’t want to really jeopardize or damage the skin. It really is the limited dissection, not evertting the patella, not violating the quadriceps, and it’s not really, it’s not the technique for every knee. I think it’s good to say that we will use as minimal an incision as is possible in order to achieve the principles. As we do this, there are some data and it’s slightly shorter rehabilitation, but the fact is, there are no long-term data that would really support anything other than achieving the principles of knee replacement and that’s really what we’re trying to do here and at least demonstrate to you some of the newer technologies that are available. So Wolfie, how are we coming with femoral rotation?

WOLFGANG FITZ, M.D.

Well, we have the femoral rotation established. I think I have demonstrated that quite well. We have some problem with our batteries here, as usual, so we’ll take our pin out of the femur and then I put the femoral component in. It’s a trial component, not the original one. We want to see how this knee hurts.

THOMAS THORNHILL, M.D.

So now, this tibial piece that you have here will demonstrate the rotating platform aspect of it. For the audience, you can see there’s a handle on the tibia, the lower piece, the blue trial, and there is motion or movement between that blue trial, the blue piece, and the metal piece underneath it. That is the concept of rotating platform. A fixed bearing knee will not move at that articulation. So now what Wolfgang is going to do is put a trial patella for size and now he’s going to go into extension and now he’s going to look at the flexion. Literally, these implants will give you the ability for the knee to flex as far as it needs to flex. It has the ability to flex fully. The major determinant of that really is the quadriceps tendon, the tendon in which the kneecap fits. How does it feel to you, Wolfie?

WOLFGANG FITZ, M.D.

It feels actually quite nice. I have full extension. It doesn’t flip and it’s very stable in extension. I also check it in mid flexion and you can see that there’s no opening in mid flexion. The patella tracks nicely medially. When I go in full flexion, it’s not too tight at all.

THOMAS THORNHILL, M.D.

Can you feel the posterior cruciate as you flex the knee?

WOLFGANG FITZ, M.D.
I don’t want to flip the patella because then it’s not really accurate. It’s not really tension at all. It sits in quite perfect. I like that a lot.

THOMAS THORNHILL, M.D.

It looks good. So now you’re going to mark this and then affix the components in?

WOLFGANG FITZ, M.D.

Correct.

THOMAS THORNHILL, M.D.

So now what Dr. Fitz is doing is marking because he likes the rotation. The movement between the blue piece, the tibial insert, which is going to be the articulation, and the lower base in the rotating platform will allow the tibial component and the femoral component to have better contact with one another and not have a conflict as the knee goes through a range of motion because there is some movement there.

WOLFGANG FITZ, M.D.

What I want to show you here is just for the minimal approach, you have to thin the patella, so that’s why I cut the patella first. As I mentioned, I have a little wafer that just protects the cutting surface.

THOMAS THORNHILL, M.D.

To prevent fracture or prevent scoring.

WOLFGANG FITZ, M.D.

Right. So now we do our final preparations for our femur. Actually, we haven’t looked if it’s lateral enough. It could go a little bit more laterally.

THOMAS THORNHILL, M.D.

I think one of the principles here is if you move the femoral component a little bit to the lateral side, then it makes the patella track a little bit better because almost all the patellar issues are tending to track laterally. You’re a little bit limited by the posterior cruciate. Now what Dr. Fitz is going is making the lug holes for the final component.

WOLFGANG FITZ, M.D.
Now I take the component off. This will determine, if it’s very hard, I’m going to do a porous femur. If it’s easy to get it off...no, this is good, so we cannot do a porous femur here.

THOMAS THORNHILL, M.D.

What this means is, in fixing the prosthesis to the bone, there’s two ways of doing it. One is to do this with cement, a methyl methacrylate, and we do this in most cases of knee replacement. In certain parts of knee replacements, particularly in a rotating platform, because of the way the components are inserted, if the bone cuts are good, then on the femur we will frequently do this without cement, using a porous coated implant, so what Dr. Fitz has determined in this relatively young lady, who has good bone cuts and good quality of bone, that he can do this as an uncemented implant. So, Wolfie, you’re now going to clean the surface and go ahead and cement part of the components?

WOLFGANG FITZ, M.D.

Correct. I have to prepare the tibial plateau, meaning drill a hole for the pack. You see here, this is the size of the 2.5. I move it to the posterolateral corner as much as possible, then I know if I have an overhang here medially, my correction is correct. I also know, I marked my correction so everything fits together, so I know this is the correct position of the tibial component.

THOMAS THORNHILL, M.D.

So now you will fix that to the tibia and then you will use the instruments to create the housing for the tibial insert, which will now be able to rotate in a unidirectional way around that housing.

WOLFGANG FITZ, M.D.

This is called the chimney...

THOMAS THORNHILL, M.D.

...which will just be a guide for the central drill that will go down in and has a stop so that we don’t drill too much. Then you will see, when he puts the final component in, there’s a little keyhole, so he’s putting this keyhole punch in that will allow this to occur. Now, one important thing, I think, that the viewers may question is that there’s not a great deal of bleeding here. This is because this procedure is being performed under a tourniquet. So now what’s going to happen is that Dr. Fitz is going to wash this off with a pulsatile lavage, very much like a Water Pik that you would use to clean your teeth, and at the same time, the scrub nurse is preparing the cement.

So while we’re doing this, and this will just be cleaning the bone and then cementing, let’s talk a little bit about some of the other aspects of this because, once we finish with
this, the process of recovery is really just beginning. Here you see, not this patient, but another patient, with a postoperative view, using a cruciate-sparing rotating platform total knee. You can see that it is sized well for the femur and, while it’s a short film, this is a patient who actually did quite well and the x-ray is actually about two years old.

Now, after the webcast is finished, we have a lot of things we have to do. The patient will now go to the postoperative care unit, in which case she will be cared for by nurses and will begin the postoperative medical management, which includes pain control, and that’s a very important aspect of this and we work closely with our pain management team. We will institute rehabilitation very quickly and that’s also very important, both in the hospital and outside the hospital, and gradually this patient will return to function. This is not an overnight process. The patient will be on crutches or a cane for a period of time and will work very hard at bending the knee. While we can do an operation and make that successful, one of the most important things that we really have to do here is to have a highly motivated patient who participates in that. So what we will be doing here, once we leave our live webcast, will just be the beginning of the process. So now we’ll go back to the operating room and see how we’re doing in terms of the cement. Here you see the mixing of the cement. You mix two substances. One is a powder, which is a partially polymerized methyl methacrylate, and then a monomer. As you mix this, it begins to get soupy and then it begins to get slightly viscous and tacky. As it starts to form a solid polymer, it will heat up. The reason for this...this is a mixing bowl. There are several different systems available for this. The mixing bowl you see is connected to a tube, which is a vacuum, in order to get the toxic fumes away from the patient and away from the operating team. So Wolfie, while we’re waiting for the cement to be ready, do you want to introduce us to the other members of your team?

WOLFGANG FITZ, M.D.

Yeah, I would actually, since we are basically at the end of the procedure and everything went very smoothly, I really have to thank for this webcast all these people here around the table. My fellow, Dr. Greg Martin. My PA, Kelly Bruno. Our nurses today, Trudy and Scott. Specifically Liz and Holly, who did a lot. Thank you to everybody. It’s really a procedure that can not be done without the support of excellent staff, so I’m really pleased to have all these people here.

So what I do here is basically I cement the tibial tray, as soon as the cement is ready. I put a trial insert in and a trial femur and then we hold the patella with a clamp during polymerization. That is one thing that I think is very important, with the rotating platform, because you don’t want so-called third body wear. Third body wear means that pieces of cement break off and get in between the bearing surfaces. Those pieces can scratch the surfaces, so that’s one of the rationales why, especially in young patients, I like to use uncemented femoral components, because there’s less cement involved. As you will see, I have pretty good control of the cement that will extrude just from the shin bone. So we are ready here.

THOMAS THORNHILL, M.D.
So now you can see that the cement is going in and the cement, if you look at it, is slightly viscous. You will see at it goes in, you can use your finger and coat the bone. Then we put the implant in. Then you have to be very careful to clear the cement from around the surface. So while Dr. Fitz is doing this, and this is time-limited because we want to certainly get everything done before the cement cures or hardens, so now we’ll see the tibial component or the tibial base plate going in and this is a very important principle of fixation, so now Dr. Fitz is going to pound this in with that little white pad to protect the surface so it isn’t scratched, and then we’ll clean the cement. We want to clean this cement around because that can actually limit your flexion or break off and get in the way and cause this third body wear that Wolfgang is talking about.

This is important now, to make sure that we really have this solidly down against the bone, because that will be the alignment. Since we’re going to do a cementless femur in this particular case, we will have the ability now to just cement this component and then we can put a trial tibial insert in and then a trial femur, and then we will extend the leg to pressurize the cement on the tibia and then we can go ahead and cement the patella or kneecap. Then, once the cement cures, we can remove this and then finally put the femoral component on. So there are several different ways of doing this. The other common way would be to cement all of the components, in which case you’re a little bit more critical in terms of your timing of the procedure because you’re against the clock. The cementing time depends on the temperature of the room and it depends...

So here you see the trial going into position and then we’ll place the trial femoral component on.

WOLFGANG FITZ, M.D.

It’s a little hard, with the small incision, to put the femoral component on. You have to make sure that you don’t get skin involved. Now we go in extension and we apply a little extra pressure. Now we’re going to take the wafer off, wash the patella.

THOMAS THORNHILL, M.D.

This is, again, just our pulsatile lavage. That cleans blood and debris and enhances the penetration and adherence of cement in the underlying bone.

While we’re doing that, let me go back to a question from an orthopedic surgeon in Atlanta, GA. He says, does the use of minimally invasive exposure increase or decrease the need for lateral retinaculum release to enhance patellofemoral tracking? It used to be that we would do lateral retinaculum releases in almost 30% of knees, but most of the modern designs, with deepened patellofemoral grooves and configurations of the patellofemoral joint, coupled with our better understanding of sizing and having a variety of sizes, has really cut our lateral retinacula release for patella tracking down to really way less than 5%. Theoretically, the minimally invasive technique, because it doesn’t violate the quadriceps tendon, should, in fact, decrease that even further, but again, the
important thing to understand here is that these techniques have not been done for 10 years or so and our incidence of lateral retinacula release is extremely low to begin with.

So now you see, we put the patella on. We’re pressurizing the cement with this patellar clamp and then we will clear the remaining cement and then we have to wait for a little bit while the cement cures and perhaps we can take a few more questions while we’re doing that.

So now we’ve got the leg in extension and we’re waiting for the cement to cure. Here’s a question from another orthopedic surgeon. I think it raises another very important point. How do you determine the final soft tissue tension of the knee? Well, by this period of time, when we have the components in, we really should have balanced the knee in extension, in mid-flexion, and in flexion, but we will confirm that with the capsule open. When the final components are in, we’ll look at the range of motion. We’ll check the tracking. We will check the soft tissue tension. That’s done by feel. That’s done by palpation and I think, as we see our next generation of computer-assisted navigational things, one of the really important issues will be to try to incorporate that into the software. The difficulty that we have right now is that we don’t start with the same sort of tension. I like to say that with a loose knee, you want to put it in very tight. If the knee is tight, you also want to put it in tight. I think there’s a bit of a fallacy that a loose knee is easier to bend. It is, but it also is easier to fail, so I think paying attention to this and getting the final soft tissue tension before you put the final components in is really a critical aspect of this and I think you’ve seen that we’ve done it by a variety of techniques here that are really based upon the patient’s soft tissue tension just at the beginning of the procedure. So let’s go back to Dr. Fitz and see, Wolfie, how are we doing here?

WOLFGANG FITZ, M.D.

I’m just waiting for the cement. It’s pretty cold in this room, so we have to wait a couple of minutes. I’m just getting the final components ready.

THOMAS THORNHILL, M.D.

We’ve seen the final tibia. Can you show us the final femur and show us what you mean by the porous coating?

WOLFGANG FITZ, M.D.

You see here that actually this component has beads on the surface, so you increase the surface of the component, which facilitates bone ingrowth. That is the benefit when you don’t have cement. Specifically in young patients, I think, it’s a good thing. One of the failures long-term is loosening. If there are particles of polyethylene, if they cause so-called osteolysis, very often it goes in between the interface between the bone cement and the femur. It seems in some x-rays that this porous design actually prevents the osteolysis sometimes, initially, at least.
The bone cement is still soft. It’s harder, but it’s still doughy, so it’s a little too early to release everything. The last question, I think, from the physician in Atlanta was quite good. What I’d like to tell him is, what I like here, because you cannot insert now a tensiometer…we don’t have yet, there’s actually future prospective to have inserts that measure intraoperatively the tension medially and laterally and bring it to the computer so we can document it. One thing that you can do is something that I always do. If you use the hip as a fixed point and externally rotate in the hip, you see I have barely an opening laterally. It’s about 1 mm. If I go in internal rotation, you see the same thing. There’s barely any opening. So I know that my tensiometer gave me the right tension that I like for my rotating platform knees.

THOMAS THORNHILL, M.D.

So Wolfie, now you’re going to take the trials out and put the final components in and show us the range of motion and we’ll be done.

WOLFGANG FITZ, M.D.

Okay, I can show you the range of motion right here, now. See, we have full extension and the flexion is about, I could say, 125°, so we take the components out now.

THOMAS THORNHILL, M.D.

Before we sign off in the next few minutes, I think we would like to see the final components in, if possible.

WOLFGANG FITZ, M.D.

Well, it takes me like two minutes from here. I just want to make sure that all the bone cement is out.

THOMAS THORNHILL, M.D.

While he’s doing that, let me address another question, a very good question from one of our viewers in Boynton Beach, FL, and that is, what determines the difference between a partial knee and a full knee? A partial knee is referred to as a unicompartmental knee. As you saw in the knee today, there are three compartments. There’s a medial or inside, a lateral or outside, and then a patellofemoral compartment. A partial knee replacement, or unicompartmental knee replacement, is resurfacing just one of those abnormal compartments. The knee we saw today was predominantly abnormal in the medial compartment, but there were changes in the other two compartments and therefore we did a full total knee replacement. A partial knee replacement would be if we just replaced the medial side. That technique is particularly amenable to a minimally invasive technique because you really don’t have to see the other parts of the knee.
There was another question from one of our viewers, which asked about converting a partial knee to a full total knee and that can be done. Can that be done using minimally invasive techniques? Again, that would really depend upon a variety of things. Again, from our point of view, it’s not just the length of the incision. It is the ability to do this without violating the quadriceps mechanism. As long as the surgeon is able to achieve the principles that we want, then we oftentimes can use a minimal technique on that as well, but we can’t let it limit our exposure.

Now you see that the final component has been put in the tibia and now we’re putting the final femoral component in. We’re doing this, now, without cement because we really have good bone cuts, so we have the tibia cemented, the patella cemented, the rotating bearing insert that is in, and you can see, and now finally the component. You can see how nicely that fits against the bone. Wolfie, do you see some motion in the rotating platform?

WOLFGANG FITZ, M.D.

Let’s have a look. That’s my final exam. You’ll see the knee is completely extended. The stability has not changed. You see, it doesn’t open at all in mid flexion or in flexion. I show you again the trick, go in extreme hip external rotation, hip internal rotation, and you will see there is minimal opening. I would say less than 0.5 mm. The flexion and extension is really nice. I mean, I can go all the way back here. There is no spinout, nothing in the patella. The medial facet really stays nicely on the medial condyle, so I am very happy.

THOMAS THORNHILL, M.D.

Dr. Fitz, I want to thank you and everyone in there. That was a very nice demonstration of the principles of knee replacement. I think that we have been able to introduce some of the concepts of minimally invasive surgery, some of the concepts of computer navigation, and some of the concepts of a rotating platform.

I would like to thank our audience for joining us for this live surgery webcast to talk about knee replacement. I think that the most important thing that we can talk about here is, in fact, the ability of this type of procedure, in the proper patient, to really relieve pain, restore function, restore alignment, and if you can achieve these principles, then you will frequently get an extremely happy patient, as this patient of one of my colleagues that was done several years ago here at the Brigham and Women’s Hospital has been able to achieve.

For future viewing, this surgery will be archived at the www.brighamandwomens.org/surgery webcast and you can visit our website. Please remember that CME credits are available only through tomorrow, May 21. I would also like to invite you to visit our website for archived webcasts, as well as information on future webcasts, including our next live surgery webcast on September 30, featuring
bilateral nerve-sparing radical prostatectomy for prostate cancer. Thank you and good evening.

NARRATOR

Thank you for watching the minimally invasive knee replacement surgery from Brigham and Women’s Hospital in Boston, MA. For more information, to make an appointment, or make a referral, please click the buttons below or please contact one of our skilled coordinators at 1-800-BWH-9999, Monday through Friday from 8:00 a.m. to 5:00 p.m., or send us your email at livesurgery@partners.org.