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COMPUTER-ASSISTED TOTAL KNEE REPLACEMENT
WAKE FOREST UNIVERSITY BAPTIST MEDICAL CENTER
WINSTON-SALEM, NC
May 2, 2008

00:00:10
ANNOUNCER: Welcome to Wake Forest University Baptist Medical Center. You're just moments away from seeing a computer-assisted total knee replacement live. During the webcast, you'll watch as surgeons remove the damaged portions of the knee joint and replace them with implants that eliminate the pain and allow the patient the freedom to move again. You'll also discover how computer-assisted technology provides immediate feedback as to the alignment of the instruments as well as placement of the implants. OR-Live makes it easy for you to learn more. Just click on the "request information" button on your webcast screen and open the door to informed medical care. Now let's join the doctors.
00:00:56
WILLIAM G. WARD, MD: Welcome, viewers, to North Carolina to Wake Forest University Baptist Medical Center. Today we're going to be performing a navigated knee replacement. My colleague Dr. Jason Lang will be performing the surgery. I'd like to remind all the viewers that there is an access button on your screen if you'd like to email us a question, please do so and we'll try to address all the questions that are sent to us. Jason will now tell us exactly where we are in this surgery and we'll move from that point.
00:01:26
JASON E. LANG, MD: Thanks, Dr. Ward. I'd like to also extend my welcome to everybody watching this live. We have begun the surgery on this 66-year-old woman who was seen in my clinic for left knee pain which had really started after a motor vehicle accident a number of years ago. She had maximized her non-operative treatment, including injections and anti-inflammatories, physical therapy, bracing. We went over the list of benefits of a total knee, and she wanted to go ahead and do this procedure to remove the damaged portion of the bony surfaces, replace those with metal and plastic to alleviate her pain and correct her deformity. So at the point we're at right now, we've gone ahead and done the exposure to the knee, done a standard median pair patellar approach to the knee. I've actually already cut the patella as well because I'm going to resurface the patella, which had a significant amount of arthritis and wear and tear of the cartilage there as well just to give us a little bit more exposure, gone ahead and done the patella. And as you can see here, these reference frames that are essential to doing a computer-navigated knee replacement, we've placed those on the tibial side at the junction of the -- well, I'll start with the femoral side since we've got the camera there on the femoral side. It's inside the incision, halfway between the medial epicondyle and the anterior cortex, and then right in line with that these are two 3-millimeter pins. And then you can see this is an optical reference frame. We call it the y-frame because it looks like the letter "y." And you'll hear me referring to the "y" and the "t" throughout the case. And then on the tibial side, a little farther down on the shin bone, we've got these two pins as well for the tibial reference frame at the junction of the proximal and middle third of the tibia outside of our incision, just a little stab hole with the 15 blade. And you can see the "t" reference frame there. And these optical reference frames, what they do is we have a navigation computer in the room which sends an infrared beam that then knows where in space the knee is, and we've actually gone ahead and -- can I see

the reference frame? And I've got a -- you can see this on the computer screen, this is the representation of the pointer we use to reference all these points and make a computer model of the bony surfaces that we're going to replace. And you can see it's made a -- we've generated a model of this patient's tibia, and you can see here where the worn side is on the medial or inner portion of the knee where most of her arthritis was, and that's where most of her deformity was tipping into what we call varus, or more of a bowlegged type deformity. So we've gone ahead and referenced all these points and made the computer models for the femur and the tibia. And at this point we are ready to begin the bony cuts, which we'll start with the tibia. Can I see a lateral retractor?
00:04:14
WILLIAM G. WARD, MD: Can you show on the camera at all, the infrared camera? Can you get a show so the viewers can see that? Show them that viewer there. What he's going to show you here in a second are the infrared cameras, and this sends a light signal that reflects off those reflective spheres. It's invisible to our eyes, but if you shine a light on those reflective spheres, they're very bright and it's very accurate at sending this light back. And that's what the computer utilizes to identify these points in space, and it's very precise.
00:05:09
JASON E. LANG, MD: So what I do is I use the standard external alignment frame that's commonly used in most of these procedures and I put the cutting reference frame on top of that so that I can navigate in. And if you show the computer, it's showing the model of where I have now planned to make my cut. It's very close to be neutral to the mechanical axis, a half and three off, it's right where we templated a certain 8-millimeter cut off there and dialing in a bit of posterior slope. So Charlie, go ahead and put in that second pin. I've got Dr. DeCook helping me out and one of our student doctors, our fourth-year medical student Max Langfit, is helping me out as well. Thank you to these guys.
00:05:59
WILLIAM G. WARD, MD: One of the beauties of the navigated total knee replacement, the computer assists the surgeon. The computer does not dictate where the surgeon makes his cut. The computer allows us to generate a model or a morph of what the bony anatomy is, but we still have to plan where we want to make our cut. But what the computer does help us do is once we've planned that cut, it helps us make it very precisely. And there are a number of studies that have shown the accuracy of our cuts is about 20% better if we do it with this. In other words, if you take 100 patients that have a total knee done with conventional techniques, 20% of them will have a little bit of misalignment, whereas with this far fewer will have any misalignment. So now, Dr. Lang does his knee replacements. There's two general ways of doing it. Some folks cut the femur first and some surgeons cut the tibia first. Dr. Lang prefers the tibia cut first. He already had his retractors in place to protect the vital structures in the back and on the sides of the knees, the lateral ligaments on the sides, the ligaments on the back of the knee and the nerves and vessels and important structures are all protected by those retractors that you see those gloved hands holding. And that allows him to use that saw in a safe manner. And here you see that he's cut the top of that bone off and now he's just doing a little finishing work just to get it perfectly smooth.
00:07:47
JASON E. LANG, MD: This is the worn side here on the medial side. I don't know if that projects very well on the computer, but this is really sort of hard enervated bone where that's most of where her stress has been. Again, the medial side was where her worn side was, so it tends to kick the saw up. That's why I just sort of touched it up there.
00:08:09
WILLIAM G. WARD, MD: In just a minute, he'll put the -- there he puts the reference array there. And see, the computer reads off of those three spheres and now it'll tell him how close he cut to where he planned the cut, and that's what the computer's telling us now. And the most important measurement is this varus-valgus, whether it's tilted and

bowlegged or knock-kneed position. He is 0 degrees. It's a perfect cut. His depth of cut's perfect. Everything's quite accurate with that cut.
00:08:44
JASON E. LANG, MD: So now we're going to move on to our flexion and extension gap balancing. And what we try to do, again, is to make a measured resection, how much we know we're taking off and put exactly that much back. I'm just going to pull from the end of the bed here for a second. One more time, Denise. So that's an extension that measure our gap there, then I bring the knee 90 degrees. I get the rotation of the foot appropriate. All right, go ahead. All right.
00:09:38
WILLIAM G. WARD, MD: The knee replacements that we use today, they're not a hinge. The two components are not really linked together mechanically, and so we rely on the soft tissues of the knee to maintain the knee balance. And so Dr. Lang is spending his time and his effort to make sure that he has the same amount of tension by the time he ends his surgery on the tissues on the sides of the knee and both full extension are out straight and in that flex position. Because if it's tight in one position but loose in the other, when the patient's walking around or trying to do stairclimbing or descending or something of that nature, if it's not balanced perfectly, they will feel instability, the knee will shift around, they may have discomfort and they just won't be happy with it.
00:10:28
JASON E. LANG, MD: So you can see on the computer what it's giving me is now we're navigating in the femur component. And we can change the size, we can change where we're going to navigate placement, pretty much in three dimensions, flexing it and extending it, moving it back and forth, moving it towards the foot, back towards the foot. Whatever we want to do to, again, try and balance those gaps as much as we can. And so we've decided just to flex the component just a little bit so that we don't notch or hit the anterior cortex with the saw and brought the distal resection down to about 10 millimeters, which should be -- in this lady who had a little bit of a flexion contracture -- a pretty adequate cut. Let me just see -- I'm going to take a little bit off this top side just as soon as we put our [unintelligible]. All right. So now, Max, I'm going to swap with you. All right. So next we're going to be navigating in our distal femoral cut.
00:11:40
WILLIAM G. WARD, MD: And there he's attaching -- the computer is basically determining where the saw blade's going to go. He's going to cut through that slot, and that's what that blue line is on the screen now. The blue line shows you where the saw blade would go if he cut through that slotted jig, that slotted device. And he's going to get that lined up for you. It'll become a dotted line as it's superimposed on the other lines, and then he will affix it to the bone with a couple of pins. Jason, can you show them the slots in that cutting jig there? Yeah. The saw blade will go through the slotted part, and then those holes are where the pins go that will fix it to the bone. That's just a standard cutting jig, and then he puts that array on there. Now the computer will calculate exactly where the saw blade's going to go, the same place that that array would go. And you can see as he gets it close there, that line becomes a dotted or a dashed line perhaps is a better description. And then the numbers at the bottom of the screen tell you the varus-valgus or the bowlegged knock-kneed alignment position, and then the resection one just tells you whether you need to go further down or further up. And then the flexion is how much you flex or extend that component. Of those three, the most important is the varus-valgus. That's the one we really try to get nailed down as close as we can to zero. The others can be off a tiny bit and it's really okay. It's so much more accurate than the older way of doing it anyway.
00:13:18
JASON E. LANG, MD: If you go back to the computer screen, show the audience. Again, this is just sort of our planning screen. We like to see green; green is good. It means we can feel pretty confident we put the cutting jig where we wanted it to be. Let me see the flat

foot one more time, just take a peek at it. And again, as Dr. Ward said, this is obviously not a substitute for always using the techniques and principles that you're trained to do a total knee. You're always checking and double-checking to make sure that the numbers you're getting are not inappropriate and that the cuts you're going to make are what you want. Got a z for Charlie.
00:14:14
WILLIAM G. WARD, MD: Absolutely. We already know about where these cuts are always going to be, so if it ever gave us a designation it was off, you would know that immediately just by looking. Now, you see how the saw blades go in exactly where that array was attached through that slot. I personally think that those two cuts that Dr. Lang has just performed are the most important cuts of the total knee. Now, here you'll see he's checking his cut to see how accurate he is, see how close it cut to the plan. This is within .5 or 1 degree. And there you see it's within .5 degrees. The computer will actually tell you exactly how far he's off on everything: less than 1 degree varus-valgus, less than 1 millimeter in terms of our length and our flexion. So that's excellent. If we could go to the slides for just a moment.
00:15:52
There are a number of studies that have shown the most important predictor of the long-term success of a knee replacement is putting the components in in proper alignment. And that little sketch on the left shows you you want to be able to draw a line from the center of the hip joint through the center of the knee joint and through the center of the ankle. And if all of that's in a straight line, it balances the forces through the knee. And then on the right you see a longstanding film x-ray of a patient whose had both knees replacemed, and that one's lined up beautifully. The line goes right straight through the middle of the knee joint, through the ankle, and through the middle of the hip. And that's what the computer is allowing us to do quite reliably is predicting the center of the femoral head within 2 millimeters, the center of the knee and the center of the ankle all within 2 millimeters so that we can be within 3 millimeters or 3 degrees of correct. There are a number of studies, and there's a recent one that came out that predicts that the likelihood of a total knee needing to be redone at 15 years if it's put in proper alignment is going to be under 5%. And if it's off more than 3 degrees, the chance it'll have to be redone in 15 years is 54%. And those are the five references that these authors used to estimate what this risk would be. And when you consider, if you look at the top graph, this shows how many knee replacements are performed. The top left one shows you that 478,000 were performed in the United States alone in 2004. And at the current rate, it predicts 3,481,000 will be performed annually by the year 2030. So that's a tremendous number that we need to get as correct as we can. And that graph on the bottom left shows that the predicted number of redo total knees will be 268,000 per year in the year 2030. So if we can get these lined up perfectly as many times as we can, hopefully we can keep that number as low as possible.
00:18:08
JASON E. LANG, MD: Dr. Ward, if I can interrupt you for just one second.
00:18:10
WILLIAM G. WARD, MD: Let's go back live.
00:18:12
JASON E. LANG, MD: I just want to show the audience just the next step we did. Here's the reference frame, which allows us to navigate in the rotation of our femoral component. And Dr. Cook drilled those two pins for us there after we navigated that in. And again, just using your classic teaching, my index fingers are at the medial and lateral epicondyle, and you can see that, again, sort of classic teaching, having the rotation which sill be set by these pins be parallel to your epicondylar axis, and that looks pretty good there. And then you can't see it, we still have a little bit of remnant of our Whiteside's line. Do you have a metal ruler? Just another check that I frequently do is just get the metal ruler out and just make sure, put it against those lines and make sure I'm parallel -- sorry, this line is perpendicular,

rather, to Whiteside's line. So again, the computer is great, it makes me more confident that what I'm going is going to be long-lasting for these patients. However, you've still got to go with your principles that you learned.
00:19:22
WILLIAM G. WARD, MD: One of our viewers has emailed a question in, wanting to know what the indications are for a total knee replacement and what the benefits for using the computer-assisted technique are. Basically, any joint replacement, including a knee replacement, is for debilitating pain that has not responded to other conservative, less-invasive measures. I frequently tell patients that if their knee pain is a nuisance but they can live with it, they certainly need to put it off. If they can take anti-inflammatory medications and their blood pressure doesn't go up and their kidneys can handle it and they don't have any gastrointestinal problems from it, I would put it off as long as they can. The benefits of the computer-assisted, I think the number-one benefit is this alignment we've talked about, the ability to get things straight. If we could go back to the slide for just a moment.
00:20:20
This was taken from a paper by Dr. Berrend et al, and that top line shows the rate of redos if they line it up within 3 degrees, and it's very few. But it also shows that over time, once you hit about 10 years, if it's lined up more than 3 degrees out of plane, the risk of having to have it redone is much higher, approaching 40 or 50 percent at 10 years. Let's go back live now, see what Dr. Lang's performing.
00:20:44
JASON E. LANG, MD: Now I've got my what we call the 4-in-1 block here to finish our cuts. I just did the anterior cut. You can see -- well, you can't see from that view, but from the top we've got that nice grand piano view, we call it, that we've externally rotated our component enough. Now I'll move on to the posterior cuts and then the chamfer cuts.
00:21:13
WILLIAM G. WARD, MD: Dr. Lang, one of the patients who recently had a computer-assisted knee wants to know what the recovery time would be. What do you tell your patients?
00:21:20
JASON E. LANG, MD: Well, when I talk about recovery, my standard line is that when I think about that, I think about how long is it going to take to heal skin, tendon, muscle, and bone, which is what we cut through. And I really tell patients to have in their mind somewhere between six weeks and three months, depending on age and how quickly they will heal all those things. But really, having recovering in terms of the pain being better and them getting back to the level of function where they're really starting to turn the corner and make strides, that's a month and a half to three months is about where I have them anticipate.
00:21:55
WILLIAM G. WARD, MD: I would agree with that. I think they may gradually improve a little bit more over the course of a year, but the first three months are the key time. One of our viewers asked how strong the knee will be if you have no ligaments left. Well, the side ligaments are still there, what we call the medial and lateral collateral ligaments there, the ligaments on the side of the knee. With virtually all total knee designs, they're still present, so it helps keep the knee from tipping forward or back, tipping from side to side. And you still have the knee joint capsule in the back, and once we sew things up and at the end of the case, you still have the ligaments in front that hook to the kneecap. And they all work in concert, and the prostheses that we use are designed to facilitate stability without the ligaments. There's some controversy about whether you should save or resect the posterior cruciate ligament, and I think it's about 50/50. Some surgeons take it and use a design that replaces for it. Some people leave it in place and use a design that is [a needed] design to maintain it in place. So there are really two types of total knees, and there's no convincing studies that show one is any particular better. It's mostly what your surgeon is most

comfortable with, what he has experience with. But he needs to be able to go from one to the other in special situations, and we all do that.
00:23:29
JASON E. LANG, MD: Can I get a chamfer?
00:23:30
WILLIAM G. WARD, MD: It's interesting, the interest in navigation. I did a medline search, which is a search of referee journals. And prior to the year 2000, there were zero articles in the literature. No one was doing this. This has come into its own in the year 2000. In 2001, there were 10 articles. In the year 2004 and 2005, there were 56 articles. 2006 and 2007 there were 104 articles. So this is growing. What would you guess, Dr. Lang, 10 percent of surgeons are using navigation techniques currently?
00:24:08
JASON E. LANG, MD: When they did an informal poll at this year's academy meeting, it seemed that would be a pretty appropriate estimate. And I think, you know, like you were saying, a lot of people use it for certain indications: there's retained hardware or particularly obese patients where the normal guys may not work as well, situations like that. Like you're saying, you need to be adaptive at applying this type of technology to certain special situations.
00:24:47
WILLIAM G. WARD, MD: The normal way we would do a total knee with conventional technique is we would put a rod up the shaft of the femur. So right there where we're looking -- maybe Dr. Lang or Dr. Cook can show us -- we would drill that rod right about there -- right there, actually -- and we would run that up almost to the hip joint, and then we would use that as our guide and we would hook that cutting jig to that. And we would typically cut at 5- or 6- or 7-degree angle to that. But that doesn't really tell you where the center of the patient's hip is. It's just an average correction for the average-sized patient, whereas this technique allows you to predict exactly where the center of that patient's femoral head is. So if somebody has a deformity -- and what he's doing now, he's checking his cut again to verify his accuracy. And again, you see everything's within either 1 degree or 1 millimeter or less. You have to understand, the saw blade's between 1 and 2 millimeters thick, so 1 millimeter is very accurate. But if you have a patient that has a femoral deformity -- perhaps they had a previous fracture or some other deformity -- that rod that goes up the shaft really isn't going to tell you where the center of that femoral head is. And if you've got a patient that's significantly obese, which we see more and more of in America, it also helps to determine exactly where the center of that femoral head is, because it's very hard to determine by external landmarks. There are also patients that have hardware. They had a fractured femur and there's a plate and screws that you can't get by or they've got a total hip in with the ski that comes way down the femur. So there are a lot of reasons that a lot of patients can't just use that standard technique sometimes. This certainly beats guessing where the center of the head is. Dr. Lang, what are you doing here?
00:26:57
JASON E. LANG, MD: So now I'm just going to finish taking out soft tissue from the back of the knee. We've made our cuts. I'm pretty close to being ready to trialing with some of the implants here, but they won't fit near as well. Can you give a rake to Charlie, please? Just right there. So I'm taking out medial meniscus here. Carefully.
00:27:31
WILLIAM G. WARD, MD: Those of you watching, remember, you can email us here in the operating room by clicking on the MDirect button.
00:27:50
JASON E. LANG, MD: I'm going to grab the lateral meniscus, resect that.
00:27:53

WILLIAM G. WARD, MD: We've had a viewer who wants to know what the top reason for patients needing a total knee replacement. Ninety-seven percent of knee replacements in the United States are performed for osteoarthritis, just wear and tear and worn out knee arthritis. Two or three percent are performed for all the other indications combined: rheumatoid arthritis, lupus-associated arthritis, traumatic deformity, et cetera. The top reason, vast majority is painful osteoarthritis, or worn out arthritis that will not respond to conservative measures. Another viewer has asked what the difference between a total knee replacement and a partial knee replacement is. Well, a partial knee replacement, most of them that are used today are when just one side of the knee is worn out. What Dr. Lang is doing here is he's resurfacing both condyles, or both parts of the femur and the entire top of the tibia. If just, say, the left half of that femur that's shown there, if only the left half were bad, he would only be cutting out and replacing the left half, and the bottom part where that blue top tray is sitting would only be notching out over to about where the handle is. And he would be leaving the right-hand side completely intact if that were normal. And you see this trial that he's placing in, it would only have one of those condyles instead of two. But that's only indicated if one side of the knee is still in very good condition and only one side is worn out. We call those compartments. And it's usually the inner one, just like this patient wore out her inner, or medial condyle first. That is the side we most frequently do partial, or unicompartmental knee replacements.
00:29:53
Another viewer asked, how stable do these computer-assisted total knees feel after they've been implanted? Well, they feel the same as the knees that are placed with conventional techniques. The importance of ligament or soft tissue balancing cannot be overstressed. If it's not balanced properly, there will be excessive motion, but you want a little bit of play in the joint. You don't want it so tight that it's almost squeaky tight. You want a little bit of play, and that's what Dr. Lang's demonstrating there, just a little bit of play. You want a little bit of play in flexion, a little bit of play in extension, because a normal knee, if you have somebody examine your own knee, it will have a little bit of play in it. You want it to be able to come out to full extension, or out straight. You want it to be able to flex well. And if it's placed really tight, it's difficult to get that complete, absolutely full range of motion.
00:30:57
JASON E. LANG, MD: So if you can go to the computer screen, what I'm doing is now I've got my components in, as you can see here on the camera. But if we can go to the live computer screen. There we go. So you can see our overall alignment is sort of flickering between 1/2 a degree and 1 degree of varus.
00:31:23
WILLIAM G. WARD, MD: So he's clearly going to be well within that magic 3 degrees, the holy grail that we shoot for.
00:31:30
JASON E. LANG, MD: It's looking pretty good. I might need to do a little bit on the posterior capsule for flex -- she's where she was before, 5.5 to 5 degrees of flexion. So that's pretty good. Pretty happy with that. And clinically, it looks nice and straight. Again, pretty happy with that. And then we'll look at the stability in extension, medial and lateral collateral ligaments feel good. Go to mid-flexion, and that looks great. No moving there. And then in deep flexion. That looks good there, and I'm seeing just sort of our live action flexion. She goes to where she did before. So pretty happy about that. Might do a little bit of work on the posterior capsule. That's about it. Do you want to drill the lugs? That looks pretty good. Go ahead and buy that for the lugs. And do you have the patella button? See how that works.
00:32:34
WILLIAM G. WARD, MD: He's drilling a couple holes where some lug fixation points will go. And he cements the component in. They have little projections that go in those two holes. One of our viewers wants to know what are the preoperative preparations for the procedure

and what is the ideal age for this procedure. Dr. Lang, what do you have your patients do preoperatively to prepare for this?
00:32:55
JASON E. LANG, MD: You know, one of the questions along those lines that I get a lot of times is, you know, "Boy, should I keep walking? Am I going to wear my knee out faster while I'm waiting for my total knee?" And my answer is absolutely not. I think if patients become what we call deconditioned, or sort of lose their flexibility, lose their range of motion and just sort of try and buy time, then I don't think that's a good idea. So I just tell patients stay as active as they can within the limits of their pain so that from a cardiovascular standpoint, they're optimized when they come in to have their surgery. I think that's really the most important thing. And then the optimal age, that's a tricky one. I'm not sure -- that number keeps shifting around. As our population, you know, more and more active. And I'm seeing a lot of more younger patients coming in with bad-looking x-rays, and it makes it a tough decision. It's a good question.
00:33:50
WILLIAM G. WARD, MD: I believe the national average back in 1991 was 68.5, and now it's crept down to 67.2. That's the average age of patients receiving knee replacements, so obviously there is a wide range if that's the average. There are people a lot younger and a lot older. In general, we want the younger patients to wait as long as they can, but when it's interfering with their life to the point they're miserable, in most situations that's time to proceed. One viewer would like to know who is not a good candidate for this surgery. And I would say it's the typical patient who's not a good candidate for any kind of joint replacement, and that's a patient with active ongoing infection. We certainly don't want to get this infected. Or somebody who is in such poor general health that they just can't tolerate a surgery of this nature. The tourniquet will be up for one to two hours and their arteries are very bad, their circulation is terrible, if we don't think they can heal the wound. Those would be the general contraindications to this surgery. But most anybody who's having a knee replacement, I think, could have a navigation. Perhaps the very elderly patient may not need the extra time for the navigation.
00:35:21
Another viewer has a question, their femur -- as I read this email, I think they say it's cavitated into the proximal tibia. I'm not quite sure what they mean, but it sounds like they have severe wear or erosion of the upper tibia, and so they're probably getting deformity. If it's a progressive deformity and they have arthritis and pain, that sounds like they should see somebody to get an x-ray, and they may well be a candidate for a knee replacement. And they may need a specialized knee replacement. If there's a large cavity on one side, you saw where Dr. Lang cut the upper part of that tibia square. If, say, the inner half of that was depressed another quarter or three-quarters, three-eighths of an inch, he might make a step cut. And then we have special augments that can fill that step cut back up, or special wedges if he cuts it in an angled wedge shape. So we have tremendous capability to take care of deformity to rebuild a knee that will still be lined up properly and function well and restore function and relieve pain.
00:36:39
If you go to the slide for just a moment, the viewers might get a kick out of seeing, this is the simple formula that the computer solves each time it's figuring out where a point in space is when we're trying to determine where the center of that femoral head. I thought you might get a kick out of seeing that formula. That's why we have to have the computer figure it out. We're not quite that quick. All right, let's go back live, please.
00:37:12
JASON E. LANG, MD: Just stripped a little of the posterior capsule and we'll trial again to see how we're looking. Do you have the Y and the T?
00:37:50

WILLIAM G. WARD, MD: So Dr. Lang is checking the balance. And you saw earlier on his screen that he was within 1 degree of anatomic alignment. There at the top left-hand corner of that screen, you see the varus-valgus is 0 degrees, so he is right on, he is perfect with his alignment. It's interesting, there have been a number of studies comparing the navigated total knee to the conventional technique total knee. And the navigated is so new that within the first two years, in terms of pain relief, narcotic medication, blood loss, walking ability, et cetera, no matter how you want to measure it, you can't really see a difference. The navigation has not made the clinical status better. But where those of us who use it believe it's going to make a difference is it's making us so much more accurate, so much more reliably accurate in our alignment. I recently reviewed a number of studies in the literature. If you'll go to the slideshow again for a moment. And I looked at these 13 articles that were in the peer-reviewed literature, and that was a total of 5,076 total knees. And of the ones that were navigated, 90 percent were within 3 degrees of that neutral or perfect mechanical alignment, whereas the conventional ones were only within 3 degrees 71 percent of the time. Some of the articles had the data about how much additional time it added, and the average was an addition of 14 minutes per case, or about 20 and 23 percent additional time. We can go back live now, please.
00:40:04
JASON E. LANG, MD: So now we're sort of maybe rounding second base here, heading to third. Let's see a lateral retractor. So now we've got to prepare our tibia. Lateral. And so we're finished preparing our tibia. We've got our femur pretty much done there, so we get a good look at the tibia there. Do you have a rongeur? Little high point there. All right. So we get our tibial trial there and make sure we like our fit on the tibia, on the bone. We want good bony contact all the way around. Fits nicely there, doesn't rock at all, so I'm happy about that. So Charlie's going to drill that one. Actually, do the front one first, if you don't mind. Do the front. You can pull that one, Charlie. Just those back two, the little holes. You can do that one. Just do like 2 millimeters up front on that one by my thumb. Do this one. That's good. And then Sandy's got a headed pin. Good.
00:41:41
WILLIAM G. WARD, MD: He's pinning this trial in place. And you see that central open area. He will drill down through that, because the actual implant he'll put in does have a stem on it.
00:41:54
JASON E. LANG, MD: That is nice. Okay. All right, Charlie, that other front one.
00:42:01
WILLIAM G. WARD, MD: One patient asks, can a bad knee interfere with your hips? Absolutely. A bad hip can interfere with a knee, and a bad knee will interfere with the hip. Average recovery time: most patients are in the hospital about three or four days. The older the patient is, the more debilitated, the longer they'll be in the hospital. And the younger and healthier they are, the shorter. That's the most important thing affecting how long people are in the hospital is their age and overall health. Another patient notes in their email that they have a severely bowed left knee and they need a knee replacement, but they're having foot pain because the knee is so bowed. They've been putting off the knee replacement, fearful that the damage to the foot's permanent. They want to know, can they expect less pain in the foot after the knee replacement? Probably, but they will need to see and discuss this with their orthopedic surgeon, who can look at their foot x-rays and really determine what's wrong with the foot. I don't think we can give the definitive answer there.
00:43:10
JASON E. LANG, MD: All right. The little one. Let me see that narrow saw blade first. Just the narrow saw, just to make those narrow, thin cuts. All right. We've got this punch here for the fins on the implant to control rotation. Gently tap this down. All right, looking pretty good. And pin puller?
00:43:56

WILLIAM G. WARD, MD: Dr. Lang, this looks like this would be painful if you didn't have some analgesia. One of our viewers asks, is the patient getting analgesic during and after the operation?
00:44:05
JASON E. LANG, MD: Good question. We've actually got, here at the Wake Forest, we've got a really active, really good what we call a regional anesthesia pain team which prevents most of the patients from needing to go on the breathing machine or to get a general anesthetic. And so this patient has an epidural block and also got a [sciatic] as well and also got a femoral and sciatic nerve block so that she's having a little nap up there while we're working down here. So not on the breathing machine, not intubated, and very comfortable during the case, which is absolutely, as the viewer points out, extremely important. And she'll actually have these catheters in place for a day or two after the surgery helping with her analgesia so she does not get any systemic narcotics, which make you sick on your stomach, et cetera, et cetera. So our anesthesia colleagues make our job much easier in that postoperative period and make our patients much happier.
00:45:12
WILLIAM G. WARD, MD: It's not surprising to make rounds at the end of the day and find the patient sitting in their chair, in their bedside chair, having their supper right off the bedside table that's now actually being used more like a card table and they're eating. That was not the case when they had general anesthetics. They were usually sick and hurting.
00:45:36
JASON E. LANG, MD: All right. So that's sort of our last final check now. What I did was I had done the case prior to this point with what we call a fixed bearing. Now what I have in there is actually an insert, and this type of design with this knee replacement will actually rotate to go with the kinematics and the normal motion of the knee. And so now I've switched to that and I'm just looking to make sure my stability is as good as it was before. And it looks great. Medial and lateral collaterals feel great. Go into mid-flexion, that's fine. Go into deep flexion, that's fine. And I'm watching my patella track, which is perfect and does not need a lateral release at all. And I'm watching this rotating insert to see if it spins at all. And just at the very last little bit, a little bit of external rotation, which ideally will help with our polyethylene wear down the road. So I think all things considered, pretty happy with that alignment there from the side view, as you guys can see straight out there, happy about that. And then as we saw with the computer, our alignment in the coronal plane is back to neutral, so I'm pretty satisfied with this. Hopefully the patient will be as well. And at this point what we'll do is take out our trial components and cement the real components into place. And that's what we have left for the procedure.
00:47:02
WILLIAM G. WARD, MD: Dr. Lang, how long do you think this knee replacement will last?
00:47:07
JASON E. LANG, MD: I don't give out warranties. No, you know, hopefully -- I hope this lasts her a good 15, 20 years would be my hope. I think without -- you know, as Dr. Ward was saying earlier, we don't have this long-term data yet with the navigated knees. And so I'm hoping it gives us a little bit of extra longevity with these prostheses to know that we've balanced them mechanically well. And hopefully in the long run it will give more long life to these implants. And so hopefully -- you know, I usually say to patient, I'm pretty confident that we'll be getting 10 to 15, and if we can get longer than that, so much the better.
00:47:57
WILLIAM G. WARD, MD: What are the patient's options when it wears out?
00:48:00
JASON E. LANG, MD: Well, that sort of depends on any or all of these different components can quote-unquote fail. It could be wear of the plastic here, wear of the plastic on the button. It can be loosening of the metal implants from the ends of the bone. You'll see we're going to cement these into place, so sometimes the cement can get little cracks in it and

loosen. And then there's certain other things that can happen which require taking out certain components. And in most cases, when we need to redo or to revise some of these components, we're able to do that in such a way where the patient does not lose function. But still, again, the goal is to have these patients with as long as they can with these components, because we always sort of say, we say, you know, first time's the best time. And so hopefully I've given her one that's going to be the first and last knee operation she's going to need on this side.
00:48:55
WILLIAM G. WARD, MD: Absolutely. But that's why the number of revisions is going up. More people are getting them. But that's the most common thing they do when they wear out is revise them and do it again. We do perform these in patients who have osteoporosis. We have to take special care. Occasionally we'll use longer stems on the ends of the components and maybe a stem up the femur or a stem down the tibia to help spread the stress around in a patient who has severe osteoporosis. Another viewer asks if we use anticoagulants after insertion of the knee, and every patient gets anticoagulants afterwards. The biggest risk to a patient's life is having a blood clot, which can then migrate up to the lungs, when it's termed a pulmonary embolism. And if it's large enough, the patient can actually die from that. So it's to prevent that that we give anticoagulants after the performance of all knee replacements. All patients get antibiotics right before the operation starts to minimize the risk of infection.
00:49:59
JASON E. LANG, MD: All right, do you have the punch for the tibia?
00:50:03
WILLIAM G. WARD, MD: One viewer asks, do bone spurs affect the surgery outcome? If you have extensive spurs, it can interfere with your mobility. But what we usually do -- and you didn't see it in this case; Dr. Lang performed that part of the operation before we joined him -- but we take a rongeur, which is a special kind of device, and we rongeur away the spurs that are around the rim of the bone. So the bone spurs are typically removed with this.
00:50:50
JASON E. LANG, MD: And what I'm doing now, I'm making -- as we talked about earlier in the case, these really hard, marbleized portions of the bone that's been seeing all this stress for this many years, what I'm doing is making little holes in it so that the cement, which acts as a grout, can interdigitate into the bone so that we get good fixation of the component into the bone.
00:51:14
WILLIAM G. WARD, MD: One of the advantages of using navigation is that when you do put these rods up and down the shaft of the femur and down the shaft of the tibia, it will cause fat, bone marrow fat, to enter into the bloodstream and embolize to the heart, to the lungs, and sometimes to the brain. And one surgeon performed a study where they used Dopplers on the head or on the neck of patients to look at the incidence of those emboli. The average number of emboli per case if someone had computer-assisted was less than one emboli per case. This is this little tiny marrow fragments going up to the brain. And if it was done with conventional technique with an intramedullary guide rods, the average number was 10.7 emboli per patient. So this is a huge difference. And we've all seen, all of us who've done enough total joints, you will see that occasional patient that really gets a little confused for a few days postoperatively. And then it clears. And I'm convinced myself that that's what this is from. So hopefully that will prevent that little side effect. It'll be a side benefit of navigation.
00:52:38
JASON E. LANG, MD: What I'm doing now is, with an irrigating bipolar, I'm trying to get a little preemptive hemostasis, preventing the bleeding. It'll happen when we put down the tourniquet on this posterior aspect of the knee joint, all the way around. We try and prevent any hemotoma or blood collection in the knee or to have this lady's blood counts drop too

low. So we do our best to get all the bleeding controlled before we get the implants in, because it's a lot harder to reach these spaces with the implants in. All right, that looks pretty good.
00:53:32
WILLIAM G. WARD, MD: If we could go to the slide for just a moment. This is an x-ray of a patient with a knee replacement -- or a patient that needs a knee replacement -- with a painful arthritic knee. And this is another day in the office. This is what patients come in with. And you see how bowlegged that patient is because the knee is bending in such a way that they're extremely bowlegged. And by using the navigation, this is the typical alignment that we're able to get. It's straightened out and lined up beautifully, and we would expect a good long-term result with this navigated knee. Let's go back live now.
00:54:18
JASON E. LANG, MD: And we're just sort of fine-tuning right now, getting any loose pieces of soft tissue or bone that hasn't gone away. And we're going to use a pulsatile lavage so it jets saline into the knee so that we can get the surfaces as clean as possible, again, because you want the cement to interdigitate with the bone as well as possible so we clean off these surfaces and blast away marrow and blood off of the surface of the tibia bone. Here's on the femur.
00:54:58
WILLIAM G. WARD, MD: I'd like to remind the viewers we've got a few minutes left. If you have a question, please email us by clicking on the MDirect button. I think we've mentioned, one viewer would like to know the contraindications for a knee replacement. And I would say infection or active infection is the most common or general health condition that the patient just cannot tolerate something of that nature. Jason, can you think of any other major contraindications?
00:55:28
JASON E. LANG, MD: No, I think those are really the big ones where I think I would shy away from putting an implant in somebody.
00:55:37
WILLIAM G. WARD, MD: I guess the other one is people who don't have arthritis. There are a lot of causes for knee pain, and if someone has knee pain but they don't have arthritis, replacing the knee joint is not going to make that knee pain go away. One viewer wants to know how long is the normal incision on the knee. How long is yours, Dr. Lang?
00:55:55
JASON E. LANG, MD: That's a great question, and my answer is, as long as it needs to be for me to see what I need to see and to put in a total knee that's going to last you 15 years.
00:56:05
WILLIAM G. WARD, MD: There was a lot of interest a few years ago on mini-incision surgery, and then there have been a fair number of papers showing the occasional case where the surgeon tried to do a little too much through too little of an incision and got into some serious trouble. So I think it's a good idea to try to minimize it and only do what you need to do, not just be excessive with the incision, but I think there's a few patients who've been harmed by folks trying to make it too small. Viewers, keep those questions coming.
00:56:48
JASON E. LANG, MD: All right. Dr. Cook is working on keeping the surfaces clean and dry as we sand.
00:56:54
WILLIAM G. WARD, MD: Are you mixing the cement now?
00:56:57
JASON E. LANG, MD: Not quite yet. I just want to make sure -- this brand of cement sets up pretty quickly, so I like to be ready to go once we mix.
00:57:10
WILLIAM G. WARD, MD: Do you use cement with antibiotics in it or do you cement without?

00:57:13
JASON E. LANG, MD: Not for routine primary. If there's patients who there's a reason to suspect infection, a little bit higher to worry about it. Sometimes patients with rheumatoid arthritis, diabetes, et cetera, certainly revisions. But in my primaries, I do plain cement. And this lady will get plain cement. And then I'm just going to take a look and make sure we've got everything we need to be ready to go. Okay.
00:57:47
WILLIAM G. WARD, MD: Can we go to the slide? I would like to just hit on the summary points. Basically, once you learn the technique, it is relatively simple. And the advantage is it allows the surgeon to have reproducibly good alignment with very few outliers. So the average patient, each one is going to get good alignment. It allows -- it also requires -- the surgeon to do the proper planning. But I think in the future, patients are going to demand it more in the future. I think they're going to want that enhanced measure of quality, they're going to want to know that that knee replacement that they have was put in in proper alignment. And I think in 10 years, most patients are going to have it. That's my personal prediction. We'll have to have some studies that actually show that it truly does make a difference. At this point we don't have that except for the alignment itself. And admittedly, the studies showing the failure of total knees long-term were with some of the designs that are no longer used. The total knee replacements that we use today have better metallurgy, they have better cement, they have better polyethylene, and so hopefully even those that are malaligned will do a bit better. Now we see Dr. Lang, he's packing the cement in, he's forcing it down into the intertrabecular spaces, the little interstices of the bone, because cement -- this is not glue. It has no real adhesive quality; it's more like concrete once it sets. And so it counts -- we rely on that three-dimensional interdigitation for fixation.
01:00:06
JASON E. LANG, MD: All right. Here's our tibial implant here. You can see it's a little bit different than our trial in terms of its shininess, et cetera. We put that in and we're prepared. It'll go right down where those fins go. And we'll work on getting this excess cement off.
01:00:40
WILLIAM G. WARD, MD: The viewers can see how highly polished the surface of this is so that it will have minimal wear on the polyethylene part that articulates with it. The plastic part of the knee is made of ultra high molecular weight polyethylene. That's the scientific term for extremely high-tech plastic. That's the part that often wears out on a knee replacement. And you can understand if you've got a plastic part, if you have the weight bear go through it in a well-distributed fashion, it's going to wear less than if all the weight is focused on one side or the other. And that's the purpose for getting this alignment so correct, or so anatomically aligned within that desired three-degree range. That's why we go to such great lengths to do that.
01:01:49
JASON E. LANG, MD: All right. We'll move on to the femur. Great.
01:01:55
WILLIAM G. WARD, MD: One of our viewers asked, can a patient with a collagen vascular disease have this operation? And, yes, they can. They can be lined up properly just like anybody else. So as we stated earlier, it's most commonly performed for osteoarthritis, but in patients with collagen vascular disease, lupus, rheumatoid arthritis, inflammatory bowel disease with arthritis, psoriasis with arthritis, any of those inflammatory diseases, often the bone is very osteoporotic and thin. And so it's probably even more important to get it aligned properly and balanced properly in that patient than it is in the patient with osteoarthritis with a bone that's almost too dense. Here we see Dr. Lang impacting the femoral component. And we always use excess cement so that it'll pressurize it well into the interstices of the bone, and then he uses those instruments to remove the extra cement. Despite all our sophistication, it still has a bit of an appearance like shop, which is probably why orthopedic surgeons love their work so much. We all like doing things with our hands.

This is a perfect balance of doing things with your brain and doing things with your hands. Now, that is the final component, the metal part. That's a trial --that blue part, that plastic part is just a trial. And he'll most likely place the knee in full extension here in just a minute while he works on the patella, or the kneecap. That way he'll put the heel -- he'll rest the heel on a bump, or stand. That'll pressurize those two parts together. And he's cleaning out the patella, which he had previously prepared, cut it off square and then drilled a few holes, partial holes, again, to give that three-dimensional interdigitation. There you see an excellent view of that. He's going to force a little cement in the three holes, force the cement into the interstices, and then he'll place the patellar component, which you'll see on the backside of that has some cement already applied and it's got those three pegs that fit in those three holes. He gets it started by hand to make sure it's lined up well, then we have a special compression device that squeezes the two together. You'll see the excess cement ooze out.
01:05:31
JASON E. LANG, MD: I'm going to grab the sucker and get these little pieces. And then we just look around for excess cement that has squirted out the side with pressurization. We don't like to leave any excess cement. It can generate wear on the plastic part in particular. We have to be really careful about getting all that. That's sort of how it'll look, more or less, other than the blue plastic. We'll again take another look on the inside of the knee with this trial plastic out so that we can look for excess cement, make sure we haven't left any excess cement in there. I do like to drop the tourniquet at that point and make sure I get good hemostasis and then wash it out and then put the real plastic liner in, and then that's -- then we move on to closure of the wound.
01:07:12
WILLIAM G. WARD, MD: And that's not a particularly long incision there. Dr. Lang, you've done a beautiful job with this. This patient should do very well. The final component will look -- the final polyethylene tibial try will look the same as that patellar component. They're the same polyethylene basically.
01:07:40
JASON E. LANG, MD: All right, so we'll just wait for the cement to get hard here.
01:07:45
WILLIAM G. WARD, MD: This is the hurry up and wait portion of the case. So we've taken our time with this operation, and I think we started at exactly 12:00, and you can see that it's about 1:08. So even with the time to teach and demonstrate, it's only just a little bit over an hour. Navigation typically takes 15 or 20 extra minutes, but I don't know about you, Dr. Lang, but I have never had a patient ever say to me, "Well, Dr. Ward, I just wish you'd have rushed through my operation. I'm sorry you took that extra time to get things lined up just right." I've never heard that comment, nor do I ever expect to.
01:08:35
JASON E. LANG, MD: I think you're right. I think that's a great point. I think it's well worth that extra 15, 20 minutes to give the surgeon good peace of mind and as well as the patient, good peace of mind that you've done everything possible to ensure good performance.
01:08:57
WILLIAM G. WARD, MD: Before we go offline, viewers, if you have any questions, please email them to us.
01:09:14
JASON E. LANG, MD: So this lady will tomorrow -- because we sort of talked about we'll begin getting her out of bed beginning tomorrow. Patients can put all of their weight -- we call it weight bear as tolerated. She will have pain, so she probably won't feel like putting all of her weight on that side, but from a structural standpoint, the cement is as hard as it's going to be in about 24 hours. And so she can tomorrow morning begin getting up out of bed and begin working with the physical therapist. The initial time is really spent with learning how to walk around with either -- usually a walker for the first 10 days, two weeks,

or so. Again, taking a little bit of weight off just from a comfort standpoint. And then moving into a phase of motion with the knee, because this lady had, other than her arthritis, or despite her arthritis, had a really nice range of motion. And so what we really want to do is to have her have not only pain relief but go back to that great function she had before. So motion and having the physical therapist really work on both extension or straightening and flexion or bending so that she gets and maximizes what we've done here and from a functional standpoint maximizes what we've done here, and that process begins tomorrow. You know, I usually -- when I see the patient in the afternoon, I'll tell him, you know, I said -- I joke a little bit and I say, "The easy part's done, and now the hard part begins." And the patients really do need to work hard and be compliant with their therapy and do their therapy exercises every day, twice a day, and really work hard to have a really good outcome. And so that begins tomorrow. We have a really good physical therapy team here that does a great job getting these patients started and does a great education job with the patients as well. And so she'll get one night, one night to rest, and then she gets to work.
01:11:09
WILLIAM G. WARD, MD: What about stairclimbers?
01:11:11
JASON E. LANG, MD: We normally, from a functional standpoint, again, from a strength standpoint, I do go up into the quadricep tendon, so there can be some instability, or what we call quad inhibition, a little bit of weakness of the quadricep muscle. But we actually, at the stick center where we have our total joint unit, we actually have a gym that's right there with a little play set of stairs, about three or four stair rises that patients can work on that before they go home and so they can see, "Yes, I can do it, here's how I do it," and they get trained and taught how to do it in a safe manner before they go home.
01:11:47
WILLIAM G. WARD, MD: And what sort of motion will your patients have before they leave?
01:11:50
JASON E. LANG, MD: You know, before they leave, as long -- what I really like for them to do is just to see that they can move it, bend it safely and it really doesn't hurt that bad and they feel comfortable doing it. When I see them at two weeks, I'd like them to be at 90 degrees of flexion and pretty close to full extension. I really emphasize to my patients extension as sort of the forgotten direction and motion. And then, you know, when I see them at the two-week visit, if they're 80 to 90 I'm pretty happy. When I see them at six weeks, I'd really like to see, you know, for this late I'd really like to see her 110, 115 at that point. All right, well, at this point, for functionally -- or for the rest of this procedure, again, we're just going to take out this last remaining trial, make sure we've cleared out all the cement, make sure we get hemostasis, pop in the polyethylene liner here, and get to closure. So that's about it. I'd like to thank everybody, and I'd like to thank everybody here in the OR who did a great job helping us do a good knee for this lady. And thanks for everybody on the Internet for watching.
01:12:58
WILLIAM G. WARD, MD: We thank all our viewers for joining us here at Wake Forest University Baptist Medical Center. And if you missed any portion of this webcast and would like to watch it again, it will be available and archived later this afternoon. For Dr. Lang and myself and all the staff here, again, thanks for joining us here at Wake Forest University. We hope you enjoyed this.
01:13:26
ANNOUNCER: Thank you for watching this computer-assisted total knee replacement from Wake Forest University Baptist Medical Center. OR-Live makes it easy for you to learn more. Just click on the "request information" button on your webcast screen and open the door to informed medical care.
01:13:50
[end of webcast]