[MUSIC PLAYING]

JIMMY CHOW: Welcome to St. Luke's Medical Center in Phoenix. This is OR8. Thank you very much for having us. Dr. Bertrand Kaper and myself are going to be performing a live surgery with unicompartmental knee arthroplasty. It's the JOURNEY uni arthroplasty, and it's going to be done with a Blue Belt Navio robotics system.

Our patient today is a 50-year-old professional, active male with medial compartment arthritis and no symptomatology whatsoever in the remainder of his knee with intact cartilage services as well as intact lateral meniscus. And I would like to give it to Dr. Kaper for the remainder of the introduction. Dr. Kaper?

BERTRAND KAPER: Dr. Chow, thank you. Dr. Chow is going to obviously do the live surgical demonstration. And that'll be an excellent opportunity for you to actually see how we do things in the operating room blending in the robotics technology.

Sorry, I apologize. If you do have a question during the course of the procedure or the press presentation, obviously just click on the Ask the Question tab, and then we'll see if we can incorporate your concerns, questions into our presentation.

So we're going to be talking about the uni knee. It's interesting because in orthopedics when Dr. Chow and I talked to our colleagues not all of our colleagues are doing partial knee replacements. He and I are obviously believers in this operation. We have done it for many years with very good outcomes. And this slide basically is just a reference for showing that it's also not just our own individual outcomes but the published outcomes that are very strongly in favor of partial knee replacement surgery.

In the era of the medical environment that we practice right now trying to be cost conscious, aware of reimbursements and costs to the medical system, this is an excellent way to go. When I look at my practice, 18% of patients that I see for knee arthritis who are deemed to be surgical candidates, 18% are candidates for partial knee replacement. Some people may say up to 20%, but I think that's the average number that most of us would reference.

So when we talk about the Smith and Nephew JOURNEY knee, this is an implant that's been around for many years. I've been using it in my practice for almost eight years now. The benefits as I have shown on this slide here are that we've had both an anatomic shape to the femoral component and an anatomic shape to the tibial component. And you'll see that when Dr. Chow gets to the point of ready for implantation of the prosthesis.

Just some basic function engineering principles that are laid out on this slide talking about the radius of curvature, the lug preparation from a surgeon perspective allows us to change sizes either upsize or downsize depending on what we ultimately decide intra-op and all of these are round on flat designs. There's no constraint on the tibial side, which is an advantage as far as being able to shift sizes up and down as we need to.

The motion, again, unconstrained round-on flat design, again, lends itself to a very natural feeling knee, which is what our patients report on a regular basis. Durability, the benefit that Smith and Nephew engineers have offered since about 2000, 2001 is a product called Oxidized Zirconium. Oxidized Zirconium is proprietary to Smith and Nephew, but it has tremendous benefit to my patients as far as the wear characteristics. And these graphs and I have on this slide here basically just highlight that.

The other concern that we are seeing a lot more of right now in the orthopedic world is metal to hypersensitivity. So this is actually what we call a delayed type 4 hypersensitivity reaction that a lot of patients-- not a lot I should say, pardon me-- but many patients can have who cannot wear certain materials, certain metals because of an allergy. So this is an x-ray, very similar to Dr. Chow's patient that we're going to be watching the surgery on today, where you can see significant medial joints space collapse on the right knee and then fairly-well preserved joint space on the left knee.

So standard surgical technique, these are the 10 basic steps that we go through when we're doing a standard instrumented uni knee which is the traditional way to go before the advent of robotics. With the advent of robotics, we're not skipping steps, but we're basically able to use the robotic technology to incorporate that the high-speed bur that you'll see Dr. Chow use for the bone preparation as opposed to us using standard instruments and saws.

So the question comes up and that I discuss with my patients regularly is, well, what is the benefit of robotics because people hear about it. You may have heard about it through whatever channel, and so why do Dr. Chow and myself and other colleagues and I consider it? Really what we're talking about is accuracy and precision, and I'm not going to bore you with lots of engineering terms, but these are the two critical terms because when we look at the traditional instrumented UNI knee without the robot, basically we're relying on surgeon judgment to make the assessment of where do we make our bone preparation? How tight do we make the knee? All these things that we can now incorporate into robotics.

So there are different robotic systems out there. Some require a pre-operative CT scan. Others, such as the Navio that we're going to see today, do everything with intraoperative 3-D mapping, and that's going to be the main difference that you'll see in terms of the data input that we then rely on as surgeons.

So when we look at the benefits, again, what we as surgeons try to do is blend the benefits that we are trying to achieve for our patients with the benefits that the patient-- the goals that the patient is trying to have. And when I talk to my patients, the key thing that really gets them excited is I tell them you don't really need to be in the hospital. We're doing this surgery in the hospital, but I'll have to ask Dr. Chow in a little while if he's planning on sending his patient home later today or perhaps in the morning, but it's typically a very short hospital stay or even done on the outpatient basis.

There's minimal blood loss. The rehabilitation for most of our patients, I basically tell them that we cut the rehab in half from a standard total knee replace. So orthopedics, we're not the only ones that do robotics. Most of our surgical colleagues use robotics in some place in their operating rooms. The da Vinci robot is probably the robot that most patients and surgeons are familiar with.

But the difference there is that my urology colleagues take the prostate out. They're not putting anything back. What we're doing is removing damaged bone and cartilage and then trying to replace that-- working to replace that with artificial prosthetic materials and implants. So there's a rather large difference between what we do versus our other surgical colleagues.

So rationale, we're trying to simplify and reproduce the same precision every single case not just for the patient today, but for the next patient Dr. Chow does tomorrow or Friday that I do. We're trying to do it the same way every time and get the same high precision every single time. So we can do this with appropriate bone preparation, balancing of the soft tissues, which is very unique to this system and, as Dr. Chow will demonstrate, trying to minimize the degree of bone resection during the procedure.

So these are, unfortunately, x-rays of patients that I've come across over the years. They tend to be patients who are not happy unfortunately. And I won't go into all the different details about why these five patients weren't happy, but at the end of the day really the difference was that they did not have the implant put it in the optimal position. So again, it has to do the accuracy of component placement that is really a strong dictator to the success of the operation.

So when we look at what impacts the results of unicompartmental knee arthroplasty, all of these that I have listed on this screen are important. But what we're really focusing on today is the accuracy of implantation. How well can the robot make us better in the operating room?

So it's not that we're letting the robot do the work because, as you'll see with Dr. Chow, he's actually controlling the robot. He's not sitting at a remote terminal. He's actually running the robot. So he has complete control over this, but he's controlling that robot to improve the accuracy of implantation.

Prerequisites for having the robot with us here in the operating room, safety is always number one, improving efficiency, improving efficacy of the surgery, affordability, and then from the surgeon perspective, the downstream benefit because if our patients have the robotic partial knee done with us, and they're happy with the result, needless to say, that's good for everybody. Upsides, this is not 1970s technology. This is highly-engineered technology that we get to use here in the operating room that allows us to reduce our inventory, reduce turnover time between cases. And we just see the applications and outcomes just getting better and better for our patients.

Downsides, admittedly this is not cheap technology. Just like anything else in our world, if you want something, the latest and greatest, you're going to have to pay for it, but there is a fairly broad variation in terms of the cost. Some units are up to a million dollars or more. That's pricey. A lot of facilities, ambulatory surgical centers and hospitals, it's just not in their budget realistically.

There is a learning curve, and we'll talk about that. Dr. Chow and I were chatting about that earlier, and so if the learning curve is somewhere perhaps be 10, 20, 25 cases, a surgeon who only does 10 cases a year for partial knee replacement, that's a long learning curve. And so that's something that will influence the benefit of robotics. Surgical time, the first couple of cases definitely take more time, but just like anything else, the more we do, the better we get.

Just for background history on the Navio PFS, basically it's a system that the first case was done over three years ago, three and a half years ago almost now. And this slide admittedly is about six months old, so the numbers as far as total number of cases that have used this robotic technology is higher than 1,500 at this point. But that's still a very small number when we look at the total number of partial knee replacements and total knee replacements that have been done in the United States, not to mention worldwide. So we're still very much in our infancy, if you will, of robotic partial needs.

With the Navio, again, the one clear benefit that we see to our patients is that they do not have to go for a preoperative CT scan. CT scan exposes the patient to radiation. If we can avoid that, that's better for our patient.

And we can do everything with intraoperative data acquisition, input it into the computer, all done real time in the operating room. So it's not virtual reality, but it's very close. We have the ability to get balance, which means to balance the knee when the knee is straight as well as when it's in its different flexion cycle. And we have a semiautonomous, which means, again, the surgeon ultimately controls the system.

There is the capital expense. ASE refers to ambulatory surgical center. I mentioned no preoperative CT scan. When we're dealing with a patient who is on private insurance, in other words, not government sponsored, then a lot of these insurance companies are looking very closely at the amount of money that is being spent including what the cost is of a preoperative CT scan. We try to minimize the radiation needless to say.

But then the true advantage, I think, is that this system does not force a surgeon to use a specific implant. So Dr. Chow will be demonstrating the Smith and Nephew JOURNEY uni knee in the setting of the Blue Belt Navio. But admittedly, he could do it with one or the other orthopedic company's implants as well. He's not forced to do that. And so that allows the surgeon to maintain control over his or her choice of the implant, whatever he or she has had the best experience with, and which implant has the best long-term track record.

So it would be appropriate, of course, to say, OK, well, where's the beef? What kind of data do we have to support this? And so we have four studies. Again, this is from the early 12-to-16 month experience with the Navio.

This was done out of the Philadelphia group, Jess Lonner, where they studied cadavers using three surgeons. And basically, they looked at the accuracy of how close they were to the goal of position. And you can see these numbers are very, very tight, very good accuracy.

Did they achieve the limb alignment? Less than one degree off the planned alignment in 92%

of cases, again, very convincing data. No soft tissue complications in over 500 cases.

And then the learning curve, again, they thought it was about cases. I think Dr. Chow and I, I would say, slightly higher. So some good initial data, we'll expound on that hopefully over the next several years as we get more experience with this system.

So in conclusions, these are all the reasons why surgeons like Dr. Chow and I consider using the Navio robotics. And again, ultimately we're trying to do what's best for our patients so that they have the best outcome. We meet their expectations, and they're happy, and they're going to go on to be able to carry on life without the pain from the arthritis. So with that, I'm going to turn it over to Dr. Chow. How we coming over there, Jimmy?

JIMMY CHOW: We're ready.

BERTRAND KAPER: Excellent.

JIMMY CHOW: So just to kind of put this frame of reference, so both Dr. Kaper and I are both very experienced at other robotic systems as well. And one of the things that we've done here, I've already done my approach. It's actually a subvastus approach, a mine-subvastus right down the side of the patella.

My incision is from one finger breadth of mine south of the pole of the top of the patella about one finger breadth south of the top of the tibial tubercle. Obviously, that's not that important. We can change that, but that's where I start.

I've already exposed the inside of the knee joint itself. I put my pins in for my arrays. This is in the tibia proximally. This is in the distal diphyseal flare of my distal femur. And I'll use some Gelpis to give me some exposure.

BERTRAND KAPER: So just to interrupt there, Jimmy. Just for those-- I can preempt some questions probably. We were talking earlier, subvastus approach is your typical approach of choice, going underneath the VMO, and I use the minivastus approach just trying to be careful with that extension mechanism the best we can.

JIMMY CHOW: Sure. And what I find is that whenever you're doing this, I mean, the traditional place to put computer nav is right up in here. I find that can bugger up your extensor mechanism a little bit especially whenever you're going through a range of motion. And so I try to keep my array in that sulcus right underneath the VMO, and what I can feel is I actually feel through here. I can actually feel the side of my femur as I'm drilling these pins.

This is something that was described in 2007 as a transepicondylar fashion of doing distal femoral array. And it kind of goes hand in hand with that midvastus approach that you were just discussing. So there are also checkpoints in both the femur and the tibia. You can see right here. And if it's not visible, they are just these little buttons that go right in. You see that.

And that acts as a point of reference for our probe. So to start off with, we're going to verify the point probe. And so this is just going to collect on the divot here. This is how you register these pieces, and they're going to register on both the femur and the tibia.

Now for those of you who are familiar with robotic surgery, this is a really common thread to all surgeries. It's also fairly common to computer nav historically as well. And now we're going to collect the center of rotation of the femur.

And the way we do that is we take this femur. And I'm going to abduct it a little bit to make it a little easier, and I'm going to start collecting points. And if you can't see the screen, the screen is showing me green out whenever it's in the right position. And if my error is not within a certain amount, then it will force me to redo this.

BERTRAND KAPER: Can we have the camera on the screen itself so we can see that Jimmy. Is that possible?

JIMMY CHOW: I don't have the camera. So you should be able to see this. How's that? That's perfect. Is that better?

BERTRAND KAPER: Yeah, thank you.

JIMMY CHOW: All right.

BERTRAND KAPER: So you want the whole circle to be green. That verifies the registration.

JIMMY CHOW: Whole circle to be green. So I'm going to do that again because I guess I had some air introduced into what I was doing before.

There you go.

BERTRAND KAPER: Yeah, circle's green. Computer now knows where the center of the hip rotation is.

JIMMY CHOW: OK, now I've also remove my osteophytes already. This is a little bit different from other methods where you need to match a CT scan. Osteophytes are important for calibration. In this case, we move our osteophytes ahead of time because it gives us the range of motion.

So this is our neutral position range of motion. And then here's our pre-op range of motion here. This is our kinematic, so what this does is it shows us kind of the kinematic position of the leg during range of motion.

And then we're going to do a stressed range of motion. Now this is a medial compartment uni, so I'm going to stress this in valgus. And I'm going to step over here for a second to do this.

OK, and this is a little bit harder to do, so I'm going to reach around to do the remainder of this. Now I prefer to do this without the use of a tool. Some surgeons will use a Bennett or a Cobb or something inside there to tension it.

My problem with that is I feel like it gives you too much mechanical advantage. You overtension the joint line. So maybe that's just my hands.

BERTRAND KAPER: No, I found the Z retractor gently displacing the joint medially works very well. Doesn't give me too much leverage like a Cobb might.

JIMMY CHOW: So something to notice here is that I'm actually interacting with the screen personally. So I actually am touching this. This is all sterile, and it gives me full control over what we're doing which is really nice because if I decided to change my workflow interoperably, I can.

So I'm going to register some points here. Center of the knee. This is the distal end of the femur, and I'm going to move because my incision is fairly small. I'm going to be moving my knee around in order to get me exposure with that mobile window of sorts to be able to get all these points.

This will be the distal end of the femur about midpoint. This will be post your aspect to the femur. And what it shows me here is it shows-- I don't know if you can see that very well-- but it shows us the points. That being the tip where the tide mark.

This is the middle of the femur. This is the posterior aspect of the femur here. This is the midpoint of the femur itself.

And one of the reasons that this is nice is because instead of the CT scan, I actually paint physically what I'm seeing right now. So this is how it's going to register the surface of the , femur and it's going to basically give me a complete view of what this femur looks like after osteophyte resection. That's exactly what I'm doing right now.

BERTRAND KAPER: So for the lay folks in the audience, literally this is as close to virtual reality surgery is we can imagine. The probe that Dr. Chow is holding in his right hand is what you see on the screen is that pencil-looking device which helps him register the femur-- is our formal medical term for that. So he's inputting the data with multiple points. Each of those little green dots is a data point that the computers is collecting to then input it as far as the native patient anatomy which then we're going to use for reconstruction purposes.

JIMMY CHOW: And they do this exact same technique in engineering when they're trying to register parts to be made on a 3D printer. They're trying to virtualize three-dimensional objects. We do exactly the same thing. It's nice to see it translated into the operating room because it's really the same technology.

BERTRAND KAPER: So now he's going to do the same on the tibia.

JIMMY CHOW: And I have control over what this looks like too, so as I move this around, I can see what I'm doing, see. So I have control over my view on the computer as well.

BERTRAND KAPER: Jimmy, the overhead light, can we move that just a little bit to your left. I think it's giving us some glare on your monitor.

JIMMY CHOW: How about that? Is that better?

BERTRAND KAPER: Oh, much better.

JIMMY CHOW: Hold on. Let's do that.

BERTRAND KAPER: Yeah, that's great. Thank you.

JIMMY CHOW: There you go.

BERTRAND KAPER: That way the audience can really appreciate what you're seeing on the computer screen itself, so again that virtual reality probe is registering the proximal tibia. He literally is just running that probe over the surface of the bone.

JIMMY CHOW: So the computer is calculating the curve now. And now that my distal femur is done, I'll do exactly the same to the proximal tibia. I'm going to externally rotate this a little bit. Give myself a little better view of the tibia itself.

And if you notice, it really does not take a lot of time to register this. I think a hangup for many surgeons is how long does this tank. It's pretty straightforward.

BERTRAND KAPER: And if it saves them the disadvantage of preoperative CT radiation exposure, that's certainly a significant benefit not to mention having to worry about whether that we can get that CT scan authorized by insurance, et cetera.

JIMMY CHOW: That's exaclty right. The insurance part of the problem becomes a bigger issue. And I hate saying that that's guiding our medical care. And many times some patients just simply can't get that kind of input cover.

So again, these landmarks, this is the central or the deep spot on my tibia. This is the anterior point. This is the far medial point of my tibia. This is as close as I can get to the posterior reference. The posterior reference is harder to realize, and this is my axis between basically the anterior and posterior anchor of my medial meniscus. So again, I'm going to register this just like we did the femur.

BERTRAND KAPER: OK. So Jimmy, we had a question about your medial pin placement on the femur for your tracking array.

JIMMY CHOW: Sure.

BERTRAND KAPER: Because I still admittedly do it from an anterior to posterior approach. And what I've found is that you have to be very careful with pin placement making sure you're centered on the canal of the femur so you're not eccentric creating a stress riser and also not tethering the potentially tight extensor mechanism.

JIMMY CHOW: That's exactly right. So like I said before, I'm actually feeling my distal femoral bone when I'm putting it in. So I puncture the skin with the pins, and then I'll feel the pin. And I will move it to the center of what I consider the side zenith of the femur to make sure that I'm center in the femur itself because I am concerned about that.

Other things to think about though are that kind of going from medial to lateral like this, when you're distal like that, you're basically in where your subvastus approach will be. So what happens is that you end up getting out of the concern for plunging to deep and of getting some named vessels on the other side which are no fun. The other thing that you avoid is you avoid the possibility of potentially taking a stress riser on the distal femur because the strongest bone in your distal femur will be the anterior cortex, and if you're not violating the anterior cortex, then the theory is that you're decreasing potential for stress riser and maybe that postage stamp circumstance in the distal femur. And those are things that I'm concerned about.

Now obviously, nothing's perfect. There are pluses and minuses to everything that you do. But those are the reasons why I decided to do it this way. And it does stay nicely out of my wound, and it makes sure that my pins are down in the metaphyseal flare, rather than in the diaphysis, where the cortex is the thickest.

BERTRAND KAPER: Right, and just a word caution obviously for our colleagues out there is be wary of your saphenous nerve as Dr. Chow has shown here. If you stay as distal as possible, the chance of you coming close to there are reduced.

JIMMY CHOW: That is absolutely correct.

BERTRAND KAPER: So again, he's still finishing up this tibial mapping as you can see there. The light gray is the outline of the bone that he's demonstrating with the different green-gray color there. And so he can paint as much of the bone as he feels he needs to both on the articular surface as well as off the articular surface both anteriorly and medially. And that way the more points of reference he establishes, the better the data is going to be as far as the accuracy of the tibial anatomy.

JIMMY CHOW: And what I was doing here is I was really trying to highlight my tibial spine right over here and my medial edge right over here because with this implant style, as with most partial knee replacements, getting front-to-back coverage is fine, but getting medial lateral coverage, you don't want overhang here nor do you want to cut out your ACL attachment. So that's why I was focusing a lot of my actual registration in those areas.

BERTRAND KAPER: So another good question for you, Jimmy. The access to the posterior aspect of the proximal tibia, any tricks on getting your probe as far posterior as you can?

JIMMY CHOW: One of the really cool things about this robotic system is that you don't have to finish registering at any point, you can always go back and forth. The workflow is not locked in. So while I haven't been able to get all the way to the back very easily at this point in time, after I've done burring a little bit, I can actually go back and re-register some of this, which is really nice. I can go back and forth and back and forth. So those are really great things to do.

Now I will also say that focusing on the medial lateral on the anterior portion is usually enough for me because we have the ability with this implant system to change what you're doing after the robotic aspect is done. So by doing the robotic part of it, we're not married to the plans that we've done. We are able to adjust the femur in all directions on all sizes, keeping the same two lug holes.

And the same is true for the tibia. The tibial pins are not actually prepared until after we're convinced that the tibia plate Is in the right place and the anterior-posterior medial lateral coverage is correct. And so we still have the ability to modify everything we've done even after we've done all the robotic preparation, and that is probably one of the biggest powers of this system that we don't see in other robotic systems.

So now I've go a plan here, and this plan is showing the femur, and it shows that map that I've showed you. And so you can see that femur here on the plan and how it actually fits the bone fairly well. What I'm going to do is I'm going to go to a cross-sectional view, and that shows me the ability-- I can go up and down and show where if you see where it's tracking here on that line. I don't know if you can see the line.

Again, I apologize. How's that? That a little better? There you go.

BERTRAND KAPER: Yeah, I think we can--

JIMMY CHOW: So you can actually see that line. And in the midpoint of tracking, what I'm going to do here is I'm going to try to match this as best I can. I'm going to increase the size of my femur, and I'm going to change my position of that implant to match the curve.

And if you look at this, I match the curve fairly well. The other thing that I'm doing here is I'm purposely leaving my front tip of my implant deep to the bone because if anything that the Oxford Experience has showed us is that that tide mark needs to go from high to low. It can't go from low to high, and so if it's buried, it's fine. If it's proud, it's not fine.

BERTRAND KAPER: That runs into the patellofemoral impingement concern.

JIMMY CHOW: That is exactly right. Now it doesn't have to be perfectly aligned in that area because really there's nothing articulating with that portion of the knee, hence the tide mark. So there's actually a groove in your natural anatomy there. So if that groove were articulating with anything, you would feel it as you're moving back and forth. So it's a kind of an interesting point.

This looks very, very close to me. I would consider going up another size just to see.

BERTRAND KAPER: You beat me to the question, Jim. I would be inclined to be slightly larger as far as the size just like you just did.

JIMMY CHOW: Yeah, you and I are on the same page with this. This is where the experience kicks in I think. I would even consider going up even higher. It might be a little too big here because what I'm worried about now is I'm worried about where it's connecting over here on the lateral side-- I'm sorry, the far medial side.

I can always rotate it in. I think here I can rotate it in a little bit to take that down. So it gives me the ability to do that a little bit.

BERTRAND KAPER: And then you already have the 10 degree anatomic shape to the femoral component to take into consideration.

JIMMY CHOW: Exactly.

BERTRAND KAPER: --to be very helpful too.

JIMMY CHOW: So I'm going to say this is close. I'm not going to say it's perfect because, as I said before, I can still change my plan later. If you notice, I went line to line on the femur, and the reason I did that is because I'm planning on increasing my proudness of my tibia component. And because this gentleman is varus, I'm going to be adding a little bit of varus to the implant in order to kind of get closer to my new mechanical axis when I'm done. So it'll be zero to the ground.

I'm going to be taking a little bit of that slope out I believe. Coverage-wise, it looks pretty good over here. And then over here, it is close.

BERTRAND KAPER: So you can see on the sagittal image there, the medial tibial spine, he really has that tibial component abutted up to the crest of that spine.

JIMMY CHOW: Yeah, and Dr. Kaper has done many of these types of unicompartmental knees. In the shape of this, you often cut about halfway into the tibial spine to do this. This is a little close for my taste, but it's OK. I would consider moving it a little more medially except for the common problem, or common pitfall, is to leave it overhanging here, and we don't want to do that.

So I may move just a hair medial there and see if it doesn't get a little bit better connection with the spine. I think that looks better.

BERTRAND KAPER: I think you have the room.

JIMMY CHOW: And if you look at the slope here, I think that looks very, very close to what we had. So with this, we can see what the gap is. And you can see in the gap here that there's overlap here, and then it goes loose. And then it goes tighter again.

So tighter being in the bottom, loser being on the top. This is very, very related to how much force I'm putting on the knee itself. So this patient did have a little recurvatum, so I expect a little tightness in extension. That's normal because of his wear pattern.

As far as the rest is concerned, what I can do is I can do one of two things. I can move his femur, and I couldn't make his femur a little bit more anterior. And that'll bring this up. And I can make it a little bit distal, and that will bring this part of it down.

Now I'm worried about this part of it over here because that may be a little too tight an extension. I don't want to give him a flexion contracture. So I'm going to bring that back up to where that was.

BERTRAND KAPER: I'll just interrupt you, Jimmy. For the uninitiated on the robotics, this is really one of the key benefits in my opinion is the soft tissue balancing because that is what I was always taught as the art of knee arthroplasty, knee replacement. And some surgeons are very well in tune and others are not. This robotic system, as Dr. Chow is demonstrating here, really allows us to try to turn the art of soft tissue balancing into a science of soft tissue balancing.

JIMMY CHOW: I couldn't agree with you more. So what I've done here is I've added one degree of slope to the tibia, OK, which has made this very flat to our zero point. And I have recessed our tibia by about a millimeter to get almost to zero here.

Now obviously, the curve is not a perfect flat line. And that's because of the patient's individual anatomy. Now I can play with this and start flexing and extending the femur. That can help, and it can't hurt in different ways. I'll show you how that changes our curves.

So I'm going to flex a little bit and again and see what that does. So what I'm doing here I'm extending the knee, and that's kind of flattening out our curve a little bit more. And that seems to be pretty good. I worry about overextending the beyond a few degrees, so I don't want to do that too much.

Also, realize that the reason this curve is here is because I have a better mechanical advantage to certain physicians in the leg. So I may have pushed a little harder here than over here.

BERTRAND KAPER: Much easier to do so.

JIMMY CHOW: And this plot is very dependent on how hard I push. So I think that's pretty darn good. Do you have input for me?

BERTRAND KAPER: You know, that would certainly be a shape of the soft tissue balance that I would accept is what I would tell you, Jimmy. So I would error on the side of leaving things slightly loose as opposed to too tight.

JIMMY CHOW: All right, do you want me to make it looser?

BERTRAND KAPER: No.

JIMMY CHOW: Happy to do so. This is good for me and my hands. And I may learn a lesson.

BERTRAND That speaks to the individual surgeon preference, Jim.

KAPER:

JIMMY CHOW: All right, so now we can adjust the ML position, and what this shows is it shows us where we're tracking. With this current plot and any anticipation, it looks like we're going to be tracking somewhere around this midpoint of the implant given that this midpoint of the femur is what's tracking itself. Granted that is a little less reliable a key, in my mind, than the other things that we're seeing. One thing that I can do to aid that is I can take out some of the rotation, kind of move it more in line with where we were thinking.

The other thing I'll tell you is that I don't believe that it's going be edge loading. I think a lot of this, once the correction is there, will decrease that. And you can see where that edge loading is occurring. It's occurring in this part of the graph and as you're flexing it, going more to the back of the implant.

So this is anticipated. This is not in reality. So this is what it looks like it's doing. Again, we have to kind of fit the anatomy that we have, so we can't change that tremendously, but we can shift the implant a little bit more medially. So I could do this-- or, sorry, more laterally, so I can do this to kind of get it to match a little better.

BERTRAND KAPER: I find I do that on a regular basis, shift that femoral component slightly medial, as close to the wall, the notch, as I can.

JIMMY CHOW: And that's exactly what I'm doing here. And so we're going to see this here, and you know what? I can always shift later too, so there's ability to do that.

This is very acceptable in my mind. I could go a little bit more, but what I don't want to do is when I go back to our-- let me see here. I won't show it now, but you can actually go back and look at where it maps. But I'm going to go my-- I think I like that. I think that's exactly where I want it to be.

So we're going to do our checkpoint verification, and we're going to go to actually doing some of this surgery finally. You know, I think these cases are about 80% planning and 20% execution. I really do. And so the execution part of it I think is less important than the planning portion of it because I feel like the execution part of it is pretty straightforward.

So now I'm going to be taking my robotic bur.

BERTRAND Jimmy, just one quick question that we got in from our viewers. It was a question about

KAPER: femoral rotation.

JIMMY CHOW: Yes.

BERTRAND KAPER: So again, I think it was pretty clearly demonstrated on the screen that we have the ability as a surgeon to adjust the rotation based on the XYZ axis.

JIMMY CHOW: That is exactly right. So I don't like changing the rotation too much. There are some strange anatomies that I do try to adjust for, but really a lot of these implants have been optimized to be around on flat surface in a certain position. So I don't want to go in a position where we're 30 degrees off axis and writing on the edge.

That being said, the fact that we can adjust for anatomies is a really powerful tool with this type of surgery because it means that we can fit anatomies with off-the-shelf implants that have been optimized for performance and better get a more custom fit, which I think historically was a downside to this type of surgery.

BERTRAND KAPER: Exactly.

JIMMY CHOW: So what I'm doing here is what's called refining. This does not have to be done in the way that I'm doing it right now, but what it's doing is it is basically taking that shape and kind of giving it a mold. So it takes off less of the cartoon when I'm burring.

And this system right here, this is a system that has burr tip that extends and contracts. So now I just burr.

[HIGH-PITCHED BUZZING]

This seems to be easier for me whenever I'm doing this in kind of a normal position to the bone itself because it'll better approximate my topography.

BERTRAND KAPER: So this is why we call this the surgeon-controlled semiautonomous. Dr. Chow is still controlling the burr with the live input from the computer and the safety of the burr tip either being outside the barrel of the burr or retracting in if he were to accidentally deviate outside the planned range.

So this is, again, the virtual reality part of it. You see the shadow. That is the probe tunnel holding the burr, and then what he's trying to do is take away purple and then blue down to the green. Green means good, and then he knows that he does not need to resect any further bone. So it's very precise getting back to some of the engineering terms that we've discussed as far as the amount of bone that is truly necessary to be removed in order for us to replace the damaged cartilage with the prosthesis.

JIMMY CHOW: Now we didn't talk about the fact that the burr itself has actually three modes. One is a manual mode, which is basically just computer nav with the burr that's free to go without retraction or safety. One is the system that I'm using right now, which is called the safety mode, which the burr itself actually retracts into the handpiece and/or breaks in extreme circumstances.

And the last one is kind of an in-between mode and what that does is it's called speed mode. And what it does is I remove the sleeve, and instead, it goes into a variable speed motor instead. So it'll actually slow down or stop when I'm out of the range. And I'm going to be moving to speed mode here soon because it gives me better access to use the other ends of the burr.

When I'm in safety mode I want to be on kind of more perpendicular to the joint surface because it helps me with the topography. So when I start going into the posterior condyle to try to get that, I want to be on speed mode because it allows me to burr on the top and bottom of the burr rather than the end of the burr. And that's kind of a unique aspect of this system, but it's a very integral part of how to use it more efficiently.

BERTRAND KAPER: So as he's working to finish the posterior aspect of the femoral preparation, one of the interesting things that is unique about them Navio System is that, I don't know if you guys can see it on the screen, but behind the computer screen that he's looking at is the actual robotic unit which is a relatively small unit maybe half the size of my garbage can that we put at the curb. And the nice thing about this system is that it's a very portable system. It doesn't weigh 1,000 pounds. It's easy to move around, and it can actually be safely transported from one facility to the other.

JIMMY CHOW: So that's actually how we got some of this approved with our capital investment, which I know is an issue for many surgeons out there is that we actually are sharing the system with two hospitals. So two hospitals paid for this together rather than one hospital paying for it in their capital budget. So that's a big deal. That's makes this more available to many of us out there who are worried about cost containment and have to deal with a hospital approval in order to get machines of this caliber.

BERTRAND KAPER: So again, he's just taking that last little bit of the posterior femur way in the back, and so you can he's being very careful. The burr and the computer are protecting the patient if you will.

JIMMY CHOW: And the burr is being careful for me too.

BERTRAND KAPER: Yeah.

JIMMY CHOW: So the burr is not letting me do it.

BERTRAND KAPER: Sometimes it's a little bit tight to get back here, and that's why he went to that narrow sleeve that's on there so that the bulk of the initial sleeve that he was using is less likely to get in the way mechanically.

JIMMY CHOW: Now one way to take care of this also is you can actually burr the tibia and then go back. See all of my steps are right down here, so I can go straight to the tibia instead and say, forget the femur for now. I'll finish the femur later. Let me do the tibia to get it out of the way.

BERTRAND KAPER: Yeah. And in this case, it's a little tight in the back. I think that would be an excellent idea, excellent choice, but obviously you're holding the robot today, not me.

JIMMY CHOW: Let me have another lap. I'm going to protect my femoral arrays because there is debris, and I'm going to show just my tibial ray. I'm going to stay on the speed mode.

Now unlike other robotic systems, I find it's much easier to feather this system for those of you who are experienced robotic surgeons. That is to translate back and forth because with the speed burr, what happens is that it slows me down if I'm coming out of the green. And so it's good to have a little momentum built up, so it actually will cut when I get closer to the green.

BERTRAND KAPER: So this is the Oxidize Zirconium femoral component of the JOURNEY uni knee. So again, we showed the picture on the slides. It's black because the zirconium is heated to-- I believe it's 654 degrees Fahrenheit. The outer layer of this zirconium oxidizes, and basically, if you run your finger over this material, it's as smooth as ceramic.

The outer part has that radius to curvature that matches the normal cartilage of the knee. The inner part has two steps, one right here and one right here, and that's why Dr. Chow had to adjust his burr position on the femur to make sure he went around the corner here and here. And then what you saw him doing on the tunnel, he was actually reaming out, burring out, the lugs that you see right here.

And the nice thing about this system, as I mentioned earlier, is that the distance between these two lugs is the same for our standard sizes, which are size three through seven. So if he finds that his knee is too tight in flexion, and he wants to downsize that from a six to a five, even after he's put the trials in, we're still able to do so because this distance doesn't change. And that allows him to make that interoperative adjustment.

JIMMY CHOW: If I test this right here. This is measuring out to about a six front to back. What did we plan for? Was it a five?

BERTRAND KAPER: We had a five.

JIMMY CHOW: Yeah, we had a five. And I think that's probably dictated more by medial lateral coverage than anterior-posterior coverage, which is very common. Let me see the five lollipop.

So we've got these as well, and these have kind of we can put the posterior referencing on it. And we've got a six year, and that's the six that'll fit in here. And that'll probably cover well, but my issue here is not coverage. My issue is overhang.

And so I'm going to look at that medial side, and I believe there's about less than a millimeter of overhang immediately. And we've already vastly lateralized this into half of the spine, so I am not going to use this implant because that will cause some MCL-based irritation after the surgery. We should downsize to the five that we planned for, and I think that will give us the best coverage overall. Do you agree with that assessment?

BERTRAND KAPER: I would do it exactly the same.

JIMMY CHOW: Yeah, and I think it's absolutely a five, no doubt about it.

So notice that we have not drilled or put any keel holes into the tibia yet because we still have the ability to move it around, and that's part of the system. So we've got some pegs in the bottom of the implant itself right here, and we're going to find the right spot for this, knock the pegs down, and then we'll put the keel holes in after we are happy with the location of our implant.

So again, this is different from other robotic systems where you're buying your entire system during your robotic preparation. All right, [INAUDIBLE]? So I still have the ability to even adjust it at this point.

Part of the issue with this is we're going to have to kind of navigate around the extensor mechanism to get this in properly. So [INAUDIBLE] going to bend it or flex it. I'm going to get to lug started, and we're going to extend it a little bit. Go ahead, and there you go.

BERTRAND KAPER: And the trick there obviously is that you don't have to have your trial poly in there yet. He does not have his poly in there. That gives you a little bit more room to work, but the hyperflexion technique works very well to get those lugs up. You don't want to have that femoral component flex more than perhaps three to four degrees. You would agree with that, Dr. Chow?

JIMMY CHOW: I totally agree with that. I think the more you flex it, the harder it's going to be. OK, so this is an eight millimeter plastic. Know that we have the ability to go up to nine millimeters if we need to. Oh, let's go to finish.

And so seeing where this knee is working right, this feels excellent. And so here's our post-op range of motion, and it'll show you our mechanics right here. As you can see how our mechanics do not show the stress that I showed you before. Remember I showed you there was a bump in the stress, well you've hit nearly the isometric point here, which is really nice. That's why it's a nice flat curve, and you notice, this is just a little bit loose.

BERTRAND KAPER: Can maybe you or your assistant just point to the part of the screen that you're looking at as opposed to the leg moving. Yeah, there you go.

JIMMY CHOW: Right here, and so you can see how that curve is really nice. We did a very nice job of getting that correct. I would say that we probably have the ability to make it a little bit tighter so that we're going a little bit more varus, a little bit more vagus.

BERTRAND KAPER: So there was also a question about what happens if at some point the ACL has been ruptured. I've see that happen on one or two occasions. That's where I will reluctantly believe the Oxford Group that the uni knee will function well without an intact ACL. It's only been one of the two bundles that I've seen have a concern, not both bundles, so I think that gives me enough confidence.

JIMMY CHOW: Almost done, and more extreme experience of that, so right now, or in extension, we're a little bit hyperextension here. So it's about negative 2, negative 1, OK? Our varus is about two degrees varus, and that's pretty darn good for what he has. And if I want to collect my range of motion now, you can see our curve just change with that one millimeter. It's going lower, see?

BERTRAND KAPER: A little bit lower, yep.

JIMMY CHOW: Yep, and that looks pretty darn good. Now I can still go to a ten. This the system goes all the way up to about 14, I think, in this greatest point. But one thing that I'll do in this, and this is kind of a testament to what you were saying is that I will actually test my anterior-posterior drawer. If I have that anterior-posterior laxity, then I will absolutely go up a size.

But I would rather this patient be a little bit loose, especially tighter in flexion than extension. And I think this is pretty much right on the money. Just for the sake of argument, I'd like to see the 10.

Now to comment on your case, I have done several cases where the ACL is absolutely incompetent, even with a history of prior reconstruction, with the non anterior medial pattern of wear on the tibia. And I have done partial knee replacements on those cases full-well understanding that the way to get around it for stability reasons is to take out the slope of the tibia so they get tighter in flexion.

And that's a point that many that we've been arguing about now in the unicompartmental groups is whether a functioning ACL or an ACL ability to make up for an ACL to accommodate for it is a relative or full contraindication to doing the actual surgery that we're proposing. And what I will say is that once the unicompartmental knee is in place, it doesn't mean that you can't go back and do an ACL reconstruction after the fact, but obviously we'd like to prevent that from happening.

BERTRAND KAPER: Yeah.

JIMMY CHOW: OK. See if you can see this again.

BERTRAND KAPER: So again--

JIMMY CHOW: Yeah.

BERTRAND KAPER: Bottom left, there you go.

JIMMY CHOW: There you go.

BERTRAND KAPER: So this is what I was mentioning earlier, changing the art of soft tissue balancing into a bit more of a science if we can as far as alignment as far as how tight the knee is. He's looking at that graph on the bottom of the screen and--

JIMMY CHOW: I think a ten is perfect, absolutely perfect in this case. This is what I would want. And I'm actually feeling the ligament as I'm doing this also just to make sure, and yeah, this is what I would want for my knee. I think this looks excellent.

BERTRAND KAPER: Yeah, and I think the point about the collateral ligament is critical. There really should be no release of the collateral ligament for a uni knee, you would agree with that?

JIMMY CHOW: I agree with that. I totally agree with that. I think that the medial collateral is absolutely critical for appropriate function of a partial knee replacement, and I think if there's a lot of release on the medial collateral, I think you're ignoring your contralateral soft tissue balancing that you need to do in those cases so--

BERTRAND KAPER: Then I think you're going to be inclined to overstuffed the medial side, push them out of that slight varus that you want and wind up with a valgus knee, which then goes on to--

JIMMY CHOW: --early wear.

BERTRAND KAPER: --early wear in the lateral compartment.

JIMMY CHOW: Totally agreed because if you have to push that hard to correct them, you're pushing hard on both sides, not just the inside but the outside. That's really what you're saying.

BERTRAND KAPER: Yeah, six over five [INAUDIBLE].

JIMMY CHOW: But I think, so far, this looks absolutely excellent. I'm very happy with this outcome. And if you look at this, we're going to put the tourniquet up in a second here, but this knee goes. If you want to back out a little bit, maybe show the other camera, maybe that one.

BERTRAND KAPER: This if for our therapists watching.

JIMMY CHOW: Yeah, the knee goes all the way straight--

BERTRAND KAPER: We verify that.

JIMMY CHOW: --against gravity. It goes all the way down.

BERTRAND KAPER: So that's Dr. Chow's gravity flexion test with authority I would add.

JIMMY CHOW: Stable, with authority. If you want to feel a medial lateral jog that back and forth that you're seeing right there is the lateral compartment opening up. It is absolutely rockering over the medial compartment. And that's what we want to see. We want to see a fairly stable and tight medial compartment and intact an ACL and PCL excellent motion and a little bit of lateral jog based on your lateral forgiveness of your meniscus.

BERTRAND KAPER: So there was a question about how do you make the insertion of both the femoral trial with the lugs and the femoral component easy. I have my tricks. What would you share with the viewing audience?

JIMMY CHOW: So part of it is knowing-- part if it's exposure based. So if you open up the knee all the way up and you do a fairly large midline arthrotomy, it's not an issue. But if you're doing a subvastus arthrotomy or a midvastus or any version thereof, then you have to remember that you're balancing the position of the pegs with the position of your extensor mechanism. And so what I do is I start in deep flexion to initiate the engagement of the pegs, and I start extending it to remove the tension of the extensor mechanism so that I can slide it in at an angle underneath. And that's how I've been able to be very successful in taking care of that.

Can I have the tourniquet up please?

BERTRAND KAPER: The deep flexion, I think, is critical. Having slight valgus stress on the knee helps a lot. Not making the flexion gap too tight is another common mistake, or oversizing the femoral component, those would all be factors, I think, that go into that.

My technique that I like to do is I take a Ray-Tec Sponge, pack it in the posterior aspect of the joint below the tibial surface. I actually put a Cobb elevator or a blunt Hohmann in front of the Ray-Tec. Make sure the Ray-Tec is all the way behind the Hohmann, and then once I put the tibia component in, I take the Hohmann out. I take the Ray-Tec out, and it kind of just sweeps along the back to the tibial component.

There we go. Very nice.

JIMMY CHOW: So there you go. And so you can see that tide mark right over here. You can see that the cartilage right here is higher than the tide mark. It drops off just a little bit.

This is actually very congruent. This is more congruent than many of these are done. It's just that his anatomy wanted this implant a little more than some others. So we had to do a little bit less finessing in order to get this as nice as we did.

BERTRAND KAPER: I think with the real deal in place, Dr. Chow, I'll congratulate you on outstanding surgical effort. We appreciate all your expertise and advice to our viewers. And hopefully they can learn from your expertise.

JIMMY CHOW: Thank you very much, Dr. Kaper. It's been an honor to have you in my operating room, and everyone out there, thank you very much for listening and allowing us to do this today. This is really fun.

[MUSIC PLAYING]